Cheatgrass Challenge Report
FY23 – Year 2


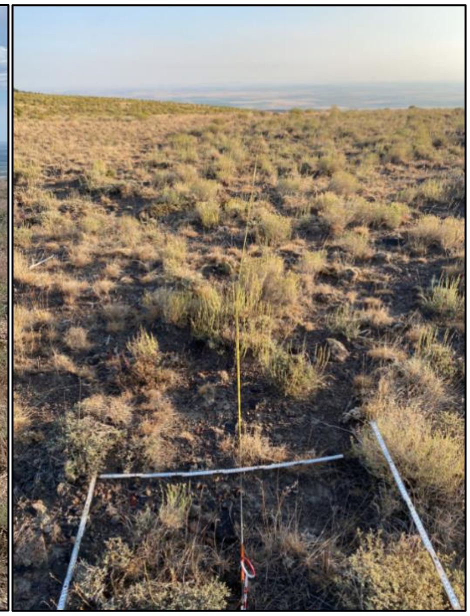

Figure 1: Photo of FY22-CC-BH-110, 6/30/22 pretreatment and FY22-CC-BH-110, 8/30/23 post treatment

Sawtooth National Forest

Minidoka Ranger District

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Cheatgrass Challenge Year 2 Post-Treatment Analysis and FY 2023 Report

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Introduction

Cheatgrass *(Bromus tectorum)* is an invasive species that was introduced to North America in the 1800s. It is a non-native annual grass generally found in sagebrush steppe community types. Cheatgrass has an ecological advantage over perennials by germinating earlier, taking all available resources, has prolific seed production, and has altered fire return intervals as well as having accelerated growth post-fire. Seeds from cheatgrass are spread anthropogenically (vehicles, shoes), biogenically (cattle) and naturogenically (wind, water, wild animals) (Bradley et al., 2017).

In 2020/2021, a new invasive grass, wiregrass/North Africa grass *(Ventenata dubia),* was found along several ridges in Dry Creek and Buckbrush Flats and has been spreading rapidly on the northern hills of the Cassia Division. It was originally found in other areas of Idaho in the 1950s (Prather, 2009). Wiregrass tends to grow in scrubland and disturbed areas, establishing first in mesic sites before spreading to drier sites (Brummer, 2013). It is an annual plant that germinates in the fall, enters winter dormancy, resumes growing and produces seed in spring, and dies in summer (Innes, 2022). Fire's effect on wiregrass spread has not been studied thoroughly enough to produce consistent results but it has been shown that wiregrass is less likely to spread after fire in grasslands/shrublands than in forested environments because more canopy is opened in forest fires than in grassland fires (Nietupski, 2021). However, wiregrass greatly increases fine fuel loads due to its densities, dryness, and flammability (Tortorelli, 2022; DiTomaso et al., 2013). By facilitating more frequent fires, wiregrass reduces the ability of sagebrush to have sufficient time to reestablish (Gibson, 2021; Kerns et al., 2020). In addition, wiregrass has little nutritional value for both livestock and wildlife, degrades wildlife habitat, increases potential for erosion, and has no economic benefits (Beck, 2014; Scheinost et al., 2008; Brooks et al., 2004). Its observed ability to outcompete cheatgrass combined with its negative ecological effects make it a serious concern for the Minidoka Ranger District (MRD). On the Cassia Division, wiregrass most commonly occurs in dense island clusters and is seen frequently in disturbed sites and micro-depressions. Livestock in the area do not forage on wiregrass. So far, it has not been found above 7,000 feet. After discovering its presence on Forest Service-managed lands, the MRD is using Indaziflam treatments to reduce the density of wiregrass and cheatgrass alike.

In 2020, the Badger Fire burned 90,190 acres on lands managed by the Forest Service, Bureau of Land Management, and private entities in Cassia and Twin Falls Counties. The fire began September 12, 2020 and actively burned for approximately two weeks. The fire was not declared "out" until January 4, 2021. The burned area is located primarily in the Cassia Division of the MRD and the BLM Burley Field Office south of Twin Falls, Idaho. Elevations range from approximately 4,200 feet along lower Rock Creek to 8,060 feet on Monument Peak. Precipitation in the fire area ranges from approximately 13-14 inches annually along lower Rock Creek to approximately 30 inches annually on Monument Peak (USGS Streamstats). Following the Badger Fire, the US Forest Service, with the assistance of Pheasants Forever and the Idaho Department of Fish and Game, aerially seeded 3,600 acres with sagebrush in the Dry Creek and Rock Creek Area.

The 2012 Cave Canyon Fire, located in the northeast Cassia burned 88,950 acres on lands managed by the USDA Forest Service, Bureau of Land Management, the Idaho Department of Fish and Game (Big Cottonwood Wildlife Management Area), Idaho Department of Lands, and private landowners. It was started by a lightning strike on August 5, 2012 and was officially out on October 9, 2012. Elevations ranged from approximately 4,200-7,500 feet. Precipitation in the fire area varied considerably as a function of elevation, ranging from as low as approximately 9 inches to a high of 21 inches in some areas (USGS Streamstats). Following the Cave Canyon Fire, the Bureau of Land Management broadcast seeded both sagebrush and grass seed, as well as planted an additional 6,000 sagebrush and bitterbrush seedlings (BLM, 2018). The Forest Service planted shrub seedlings in a few locations but did not complete broadcast seedings post fire. In general, Forest Service lands in the Cassia Division have historically benefitted from being slightly higher in elevation and getting slightly more precipitation than lower and drier BLM lands. Natural recovery is/was typically sufficient in many areas. However, many areas of Forest Service-managed lands within the Cave Canyon Fire were invaded by cheatgrass post fire.

Cheatgrass invasion was especially prevalent at lower elevations, on south-facing aspects, and in areas previously dominated by juniper. These areas previously provided valuable habitat for mule deer, sage-grouse, and elk, and were well-suited for livestock grazing and recreational uses. All of these values have been negatively affected by cheatgrass invasion.

Two SNOTEL sites on the Cassia Division, Bostetter (7,500 feet, Cassia County) and Magic Mountain (6880 feet, Twin Falls County), provide climate data (1991-2020) for areas close to both fires. On average, annual precipitation at the Bostetter site is 28.05 inches. The wettest month is December with 4 inches average and the driest is July and August with .85 inches average. The highest average temperature is 64.3˚F in July and the lowest average temperature is 23.6˚F in December. Magic Mountain's average annual precipitation is 32.82 inches. The wettest month is December with 4.82 inches average and the driest month is August with .73 inches average. The highest average temperature is 62.7˚F in July and the lowest average temperature is 24.8˚F in December (NOAA AgACIS).

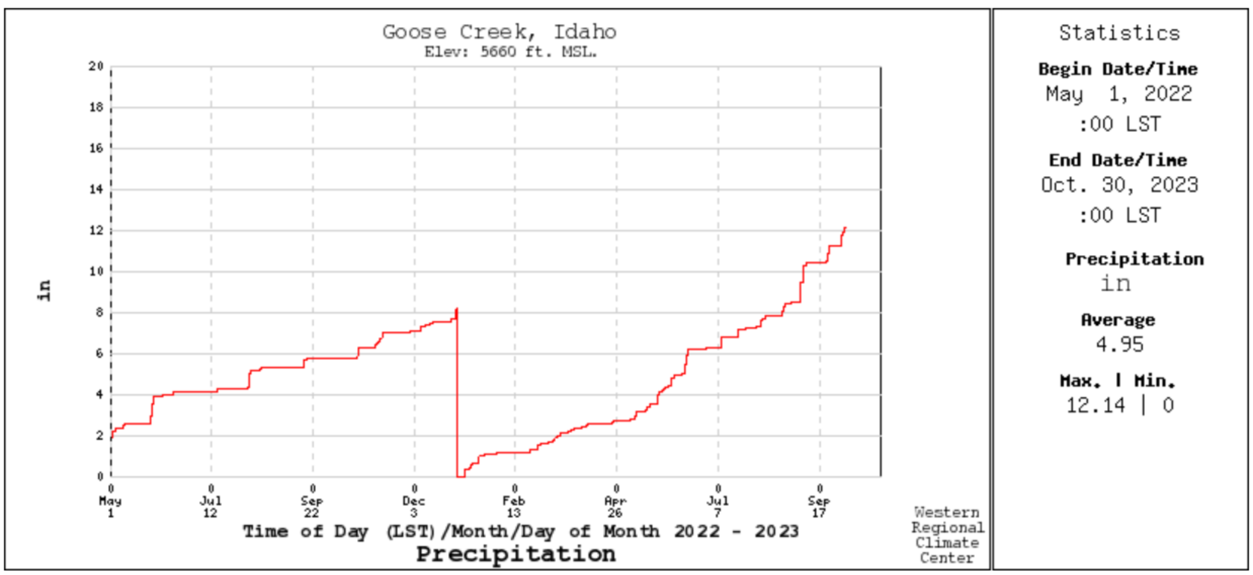

Figure 2: NIFC RAWS precipitation data on Goose Creek Site (5/1/2022-10/4/23).

Project Design

Project area site selection treatment criteria on USFS, IDFG and IDL lands included GIS mapping of expected cheatgrass invasion based on slope, elevation, aspect, and vegetation community. Those areas were then cross-walked with areas of high resource value (e.g. sage-grouse leks, critical mule deer winter range). These high priority areas were then field verified by USFS, IDFG, and IDL staff. Treatment areas were mapped into three categories: 1) Trace amounts of cheatgrass not dominating/influencing ecological processes 2) Cheatgrass is co-dominant plant type and influencing ecological processes and 3) Cheatgrass is the dominant plant type and dominating ecological processes, i.e. monoculture or near monoculture. Category 2 sites were primarily selected in year one of project implementation. The team felt most of these sites had enough perennial bunchgrasses to colonize open spaces left from cheatgrass reductions without the need for an additional seeding treatment. A small percentage of the treatments were selected on sites which were closer to category 1 and category 3 to provide the team the ability to assess the utility of the herbicide over varying extents of cheatgrass invasion. Sites selected were mostly on flatter slopes and ridgetops due to their value to sage-grouse, however canyons and steeper side slopes coming out of canyons represent a large proportion of the areas invaded in the Cassia Division. As such, a small percentage of steeper slopes were treated as well to begin to develop a baseline of information to treat these areas in the future.

Implementation

Treatments in 2022 were completed by August 29 due to the concern that the treatments in 2021 had fall cheatgrass greenup already occurring. For the second year in a row, Thomas Helicopters was awarded the contract, treating a total of 2,998 acres, which included 800 acres of wiregrass. Spraying was also done a year prior for another group of sites on September 21, 2021 totaling 939 acres. Thomas Helicopters was awarded the contract with a total cost of $60/acre for herbicide ($40) and flight time ($20). All contractor personnel were appropriately licensed/carded to apply the treatments and all spraying was done in accordance with the 2019 Sawtooth National Forest Invasive Species EIS and ROD. Indaziflam was applied at the label rate of 5 ounces/acre for grazed rangelands. After looking at treatments on the Minidoka NWR which used a tank mix of Indaziflam and Imazapic and treatments with Indaziflam only, the technical team decided against using a tank mix with Indaziflam based on the results that they observed (similar levels of cheatgrass control but more robust perennial vegetation response with Indaziflam only) and the sites they selected as the priority for treatment. See Appendices for maps of treated areas.

Sampling and Study Design

While the goal of the project is to restore functional sage-steppe habitat, a critical component of the project is to evaluate the herbicide Rejuvra™, (active ingredient Indaziflam) for effectiveness as well as learn techniques and strategies to apply this herbicide at a larger landscape scale with measurably effective results. The objective then was to begin applying these treatments in progressively larger treatments in subsequent years to further improve sage-steppe habitat invaded by annual grasses post fire.

Monitoring Protocol

Habitat Assessment Framework Site Selection

Within the project area, the monitoring site selection method was conducted using a randomly generated stratified grid pattern that incorporated known elevation, slope, plant communities, and habitat availability. Once the parameters were deployed the program randomly generated a set number of points as potential monitoring locations (Stiver et al., 2015). Sites were assigned a random number and, if no site rejection criteria were met, the site was sampled.

Habitat Assessment Framework Methodology

The Sage-Grouse Habitat Assessment Framework (HAF) (Stiver et al., 2015) protocol was used to collect pre- and post- Rejuvra™ application data. The HAF protocol is a line point intercept (LPI) protocol measuring composition, diversity, density, and canopy cover of sagebrush, grasses, and forbs. Transects were run north off a compass bearing and measured fifty meters in distance. A pin drop was conducted on the west side of the transect every half meter totaling 100 data points per site. At those pin drops, species and height of all contacted living plant matter was recorded, as well as the ground cover type. Forb sweeps were conducted every two meters by recording all forbs in a one-meter half circle from the west side of the transect line (Stiver et al., 2015). The data for these surveys was collected using the Vegetation GIS Data System (VGS) software created by the University of Arizona. The Minidoka Ranger District also required a Sage Grouse Habitat Characterization survey at each site, in which surveyors takes photos of the plot from each cardinal direction and on the ground, answer questions about land uses such as motor vehicle routes, campsites, water developments, and fences; disturbances such as fire, seeding, flooding, saw work, etc.; dominant shrubs, dominant grasses, all other species encountered, noxious weeds, and non-native grasses; snow and grazing impacts, wildlife uses, vegetation trends, and soil trends. There is also a section for other site notes and unknown plant photos.

We collected one HAF site including density protocol for every 100 acres of treatment area. Data in this report was collected one year (2023) after treatment. Plots will be monitored again at three (2025) and five (2027) years after treatment. We added a cheatgrass and wiregrass density protocol to the HAF data rather than relying on the LPI data because we wanted to assess density more accurately. There are only 100 LPI points at a site and both cheatgrass and wiregrass are small, single-stemmed plants that are not always sufficiently detected using LPI methods alone. To address this, we collected data on cheatgrass density using a frame and significance of treatment was also based on cheatgrass/wiregrass density rather than cover. Significance results for cover are still included in our analysis to compare perennial cover as we did not conduct density surveys for perennial grasses.

Cheatgrass density was measured utilizing a 50 cm by 50 cm frame that was also labeled at 25 cm by 25 cm and 10 cm by 10 cm. Cheatgrass was then counted at every 5 meters on a 50 meter transect tape either within a 10, 25, or 50 cm square frame (depending on density; denser sites were counted at 10 cm for efficiency purposes) and auto-calculated to estimate amount of cheatgrass per meter squared at each site.

Current Conditions – 2023 Year 1-Post-Treatment Analysis

Plot Naming Convention

The number system utilized to name each sampling site is based on the fiscal year the site was created, name of the project, unit/pasture the site is in, and the site number computed from a random number generator. For example, FY22-CC-BH-107 is within Fiscal Year 2022, is a part of the Cheatgrass Challenge project, is in the Big Hollow Pasture, and is site number 107. There are sites that have "VEDU" in the name, indicating that wiregrass was previously discovered in the general area of the point. While these sites were targeted for wiregrass, they still have cheatgrass and are included in some cheatgrass analyses. One point, FY22-CC-VEDU lacks a pasture and number but occurs in the West Dry Creek Pasture (WDC) and is considered point 3.

Data Analysis Methodology

Using the "Point Intercept By Cover" and "Nested Frequency" reports generated by VGS for each site, we were able to compare values for sites pre- and post-treatment. The data from the reports was exported to Excel to create graphs and run statistical analyses. Some of the data is included in the tables below. Data was collected for multiple canopy layers. As such, the percentages in the cover tables reflect cover for all layers in the canopy unless otherwise stated.

Statistical significance of changes in density and cover before and after treatment were calculated using paired t-tests. Before and after data was copied and pasted into an online t-test calculator. The calculated values were then recorded in Excel to determine P-value. A P-value ranges from 0-1 and indicates how likely it is that the changes seen are due to chance. Results were significant if there was less than a 10% chance that changes were due to random chance (P-value of .1 or less). To calculate in Excel, we entered the input =t.dist.rt(t-test value, sample size-1) for a dataset where values are expected to increase after treatment and =t.dist(t-test value, sample size-1, false) for a dataset where values are expected to decrease after treatment. Different methods were occasionally used where necessary. These include unpaired t-tests when comparing means of two separate groups with low variance, Welch's t tests when comparing means of two separate groups with high variance, and correlation when examining one variable's potential effect on another.

Foliar Cheatgrass Density/Cover Discussion

In 2022, cheatgrass density ranged from 0 to 6001.3 plants/m^2 with an average of 930.3 plants/m^2. In 2023, density ranged from 0-2366 plants/m^2 with an average of 399 plants/m^2 (Figure 3, Table 1). The 58% average decrease in cheatgrass density was shown to be significant (P=.037). Prior to treatment, cheatgrass coverage ranged from 0-79% with an average of 26.7%. Following treatment, cheatgrass coverage ranged from 0-66% with an average of 15.2%. Cheatgrass coverage significantly decreased by 11.5% on average (P=.002). Most sites saw some level of decrease, two did not change in coverage, and one increased slightly (Figure 4, Table 1). Control plots (skips within treatment areas) or adjacent untreated areas are identified for each treatment site however these plots have not been read in Years 1 and 2 due to time constraints. Control plots will be read in future years to provide a better insight into long term control of annual grasses with Indaziflam and to assess plant community composition in treated and untreated areas.

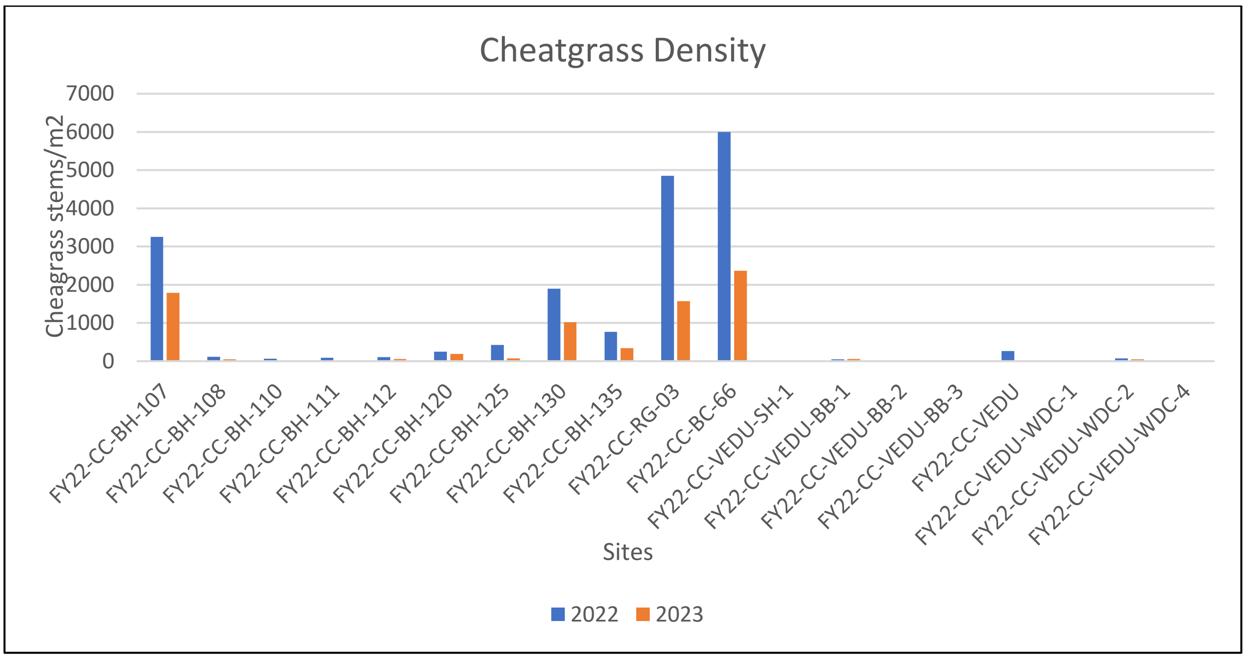

Figure 3: Cheatgrass density for all sites in 2022 and 2023.

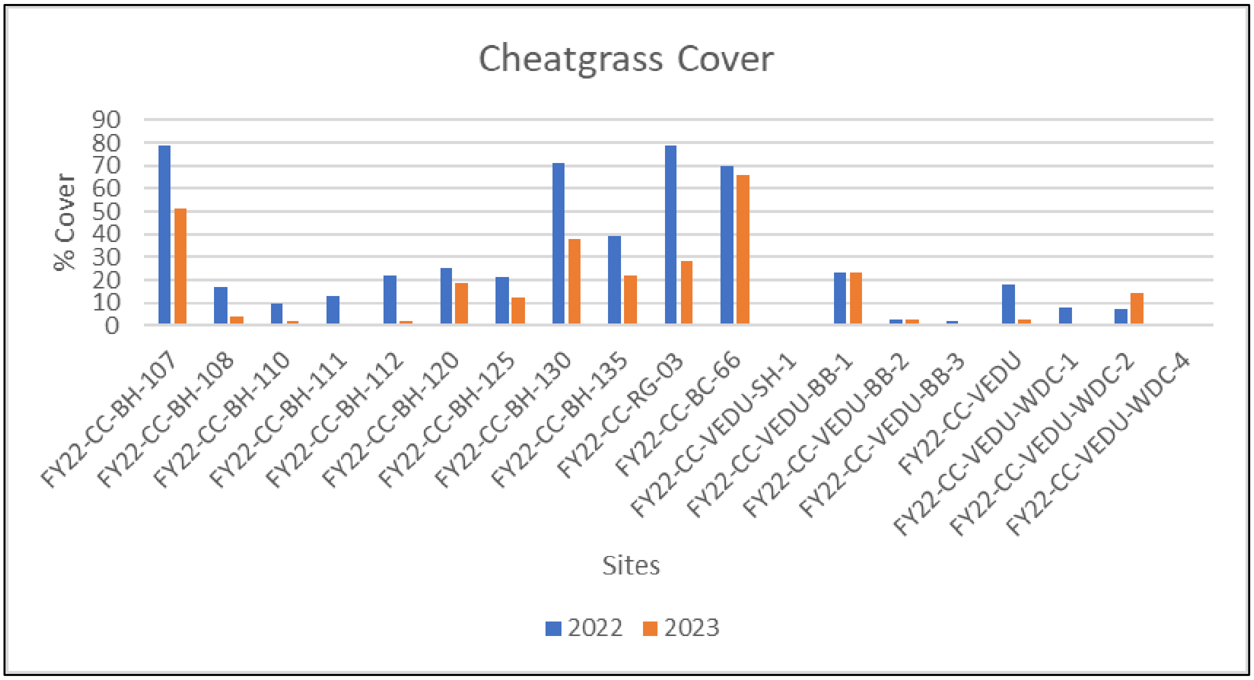

Figure 4: Cheatgrass cover for all sites in 2022 and 2023.

Site Number	Cheatgrass Density 2022 stems/m^2	Cheatgrass Density 2023 stems/m^2	Percent Cheatgrass Cover 2022	Percent Cheatgrass Cover 2023	Percent Density Change	Percent Cover Change
FY22-CC-BH-107	3251.6	1787.2	79	51	-45	-26
FY22-CC-BH-108	114.8	47.6	17	4	-59	-13
FY22-CC-BH-110	62	4	10	2	-94	-8
FY22-CC-BH-111	89.6	1.2	13	1	-99	-12
FY22-CC-BH-112	107.6	56.8	22	2	-47	-20
FY22-CC-BH-120	247.6	186.8	25	19	-25	-6
FY22-CC-BH-125	426.4	72.5	21	12	-83	-9
FY22-CC-BH-130	1897.2	1020	71	38	-46	-33
FY22-CC-BH-135	768	344.4	39	22	-55	17
FY22-CC-RG-03	4850	1571.2	79	28	-68	-51
FY22-CC-BC-66	6001.3	2366.4	70	66	-61	-4
FY22-CC-VEDU-SH-1	24.8	2.4	1	0	-90	-1
FY22-CC-VEDU-	45.6	52.4	23	23	+15	0

Site Number	Cheatgrass Density 2022 stems/m^2	Cheatgrass Density 2023 stems/m^2	Percent Cheatgrass Cover 2022	Percent Cheatgrass Cover 2023	Percent Density Change	Percent Cover Change
BB-1						
FY22-CC-VEDU-BB-2	1.2	4.4	3	3	+267	0
FY22-CC-VEDU-BB-3	0	0	2	0	NA	-2
FY22-CC-VEDU	262.4	16.8	18	3	-93	-15
FY22-CC-VEDU-WDC-1	24.4	0	8	0	-100	-8
FY22-CC-VEDU-WDC-2	71.2	50	7	14	-30	+7
FY22-CC-VEDU-WDC-4	0	0	0	0	NA	NA
Mean	960.3	399.2	26.7	15.2	-58	-11.5

Table 1: Foliar cheatgrass density in stems/m^2 and percent cover at each site in 2022 and 2023 and the percent change in each following treatment.

Wiregrass Density/Cover Discussion

Wiregrass was found in the vicinity of 8 of 19 sites. Of these eight sites, only seven had wiregrass in the transect. In 2022, wiregrass density ranged from 0 to 5689 plants/m^2 with an average of 1442.2 plants/m^2. In 2023, density ranged from 0-1778 plants/m^2 with an average of 237.7 plants/m^2 (Figure 5, Table 2). Even though decreasing by 83% on average, the changes in wiregrass density were shown to be insignificant (P= .124), however this is due to the low sample size and further skewed by one site that more than doubled in density. Given effectiveness on every other site that had wiregrass, the site that saw an increase appears to have had patchy spraying/poor herbicide coverage. When the site with the increase was removed from the analysis, decreases in wiregrass density became slightly significant (P=.08). Prior to treatment, wiregrass cover ranged from 0-84% with an average of 35.4%. One year after treatment, wiregrass cover ranged from 0-23% with an average of 5.4% (Figure 6, Table 2). Wiregrass cover significantly decreased by an average of 30% total (P=.03). Of the seven sites where wiregrass was originally detected along the transect, four of them had none a year after treatment.

Monitoring revealed multiple sites that saw wiregrass decrease from density in the thousands to zero, indicating that Rejuvra™ is extremely effective when it is applied correctly. The discussion of most improved and least improved sites later in this paper examines common characteristics between these sites.

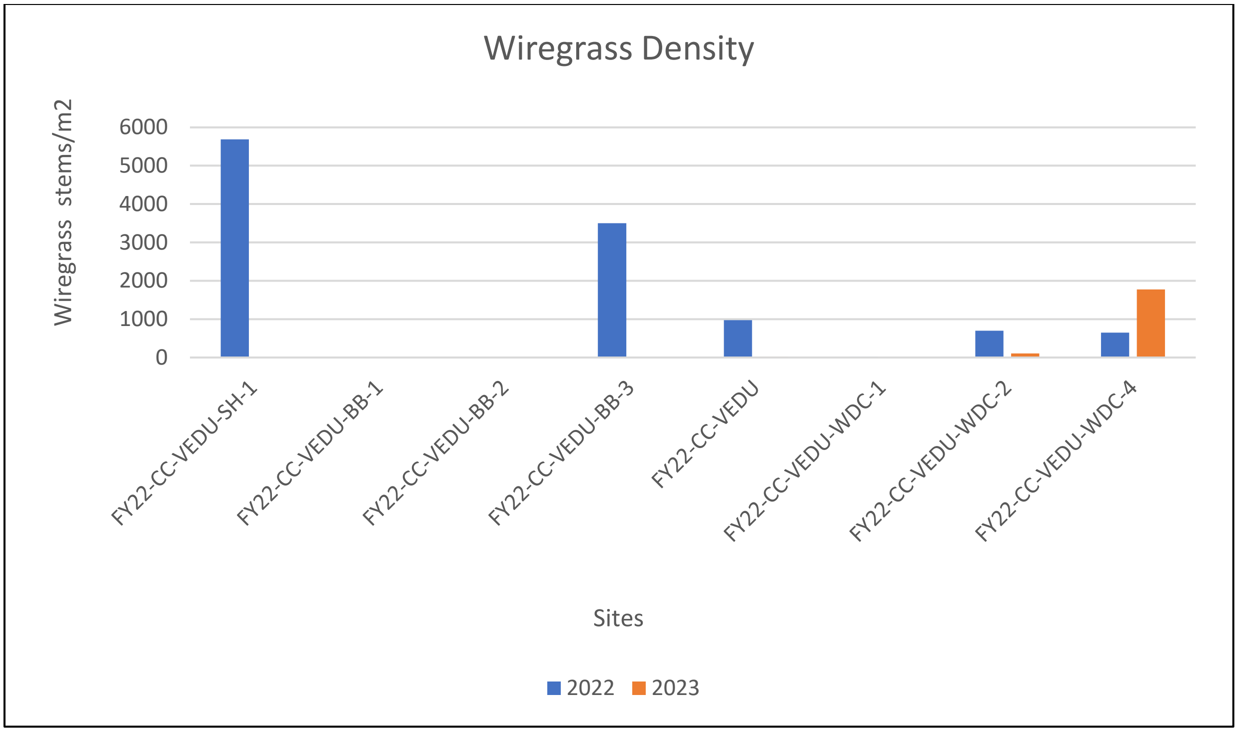

Figure 5: Wiregrass density for all sites in 2022 and 2023.

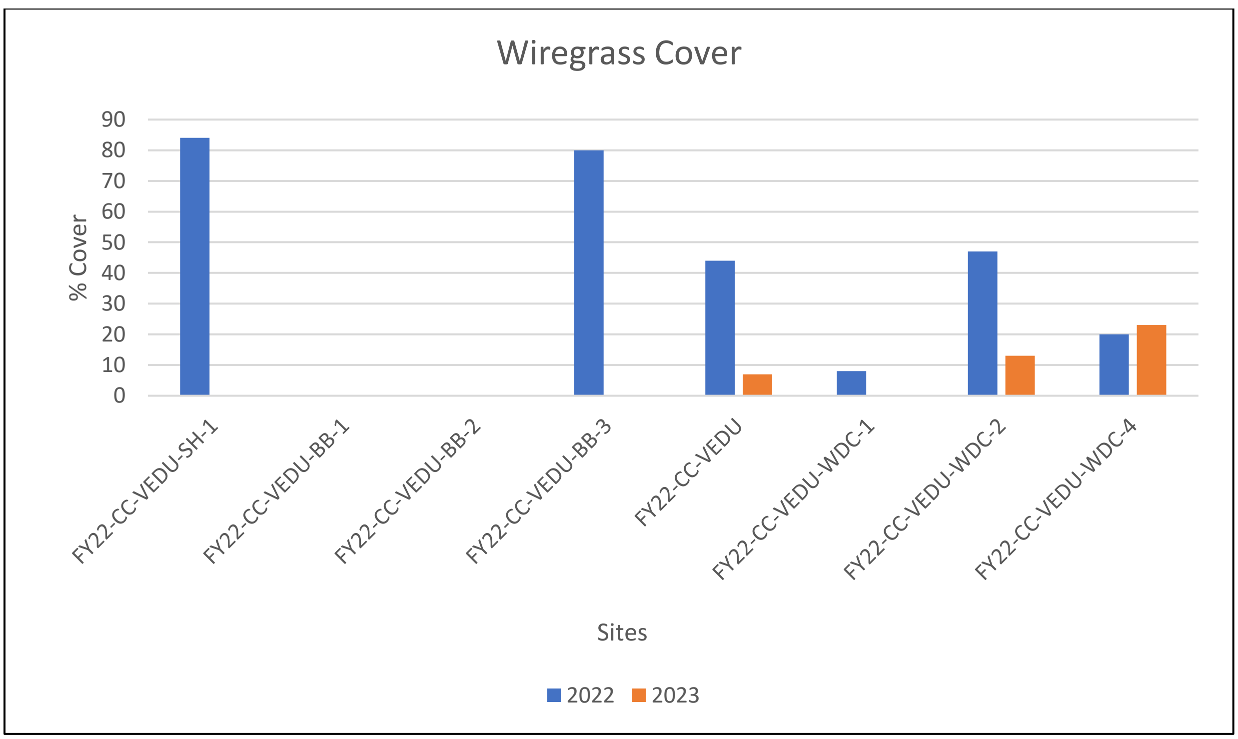

Figure 6: Wiregrass cover for all sites in 2022 and 2023.

Site Number	Wiregrass Density 2022 stems/m^2	Wiregrass Density 2023 stems/m^2	Percent Wiregrass Cover 2022	Percent Wiregrass Cover 2023	Percent Density Change	Percent Cover Change
FY22-CC-VEDU-SH-1	5689	0	84	0	-100	-84
FY22-CC-VEDU-BB-1	0	0	0	0	NA	NA
FY22-CC-VEDU-BB-2	5.6	0	0	0	-100	NA
FY22-CC-VEDU-BB-3	3500	0	80	0	-100	-80
FY22-CC-VEDU	973.2	20.8	44	7	-98	-37
FY22-CC-VEDU-WDC-1	20.8	0	8	0	-100	-8
FY22-CC-VEDU-WDC-2	698.2	102.4	47	13	-85	-34
FY22-CC-VEDU-WDC-4	650.8	1778	20	23	+173	+3

Table 2: Wiregrass density in stems/m^2, percent cover at each site in 2022 and 2023, and the percent change following treatment.

Foliar Perennial Grass Cover Discussion

In 2022, 12 of 19 sites were dominated by perennial grass, 4 were dominated by cheatgrass and 3 were dominated by wiregrass. In 2023, 14 of 19 sites were dominated by perennial grass, 5 were dominated by cheatgrass, and none were dominated by wiregrass. Even though density and percent cover of cheatgrass went down for nearly all sites, the reason why some sites were dominated by cheatgrass following treatment was because perennial grass cover also decreased steeply. In some sites, the decrease in perennial grass cover was greater than the decrease in cheatgrass cover. Values for perennial grass cover range from 18-90% with an average of 50.9% in 2022. In 2023, the values range from 7-54% with an average of 26.2%. Average perennial grass coverage decreased by nearly half from what it was in 2022 (Figure 7, Table 3). Perennial grasses had a larger rate of decrease (24.7/50.9=.485) than cheatgrass did (11.5/26.7=.431). After further analysis of perennial bunchgrass species, Sandberg bluegrass (*Poa secunda*) is mostly responsible for the significant decrease ($P<.0001$). Other key native species including bottlebrush squirreltail (*Elymus elymoides*), Idaho fescue (*Festuca idahoensis*), and bluebunch wheatgrass (*Pseudoroegneria spicata*) experienced decreases as well, but none of them were significant ($P=.29$, $P=.45$, and $P=.38$, respectively). Another perennial but invasive bunchgrass included in the analysis, bulbous bluegrass (*Poa bulbosa*), decreased significantly ($P= .051$). Overall results for perennial decrease are significant ($P<.0001$), but heavily skewed by *Poa secunda.* When *Poa secunda* is removed from analysis, the decrease in all other perennial grasses is slightly significant ($P=.07$).

To determine if current cheatgrass abundance may be impacting perennial bunchgrasses, we compared bunchgrass decreases using an unpaired t-test in sites where cheatgrass density was under 100 stems/m^2 and sites where it was over 100 stems/m^2. There was no significant difference in perennial decreases between the two categories ($P=.44$), suggesting that something other than difference in cheatgrass densities is related to perennial decline.

We will continue to explore the decrease in *Poa secunda* and see if casual factors can be determined. It is likely that due to *Poa secunda* being a shallow-rooted bunchgrass and often being established on shallow, thin soils, that the herbicide is causing injury to the species and causing the decline. It is also possible that *Poa bulbosa* was misidentified as *Poa secunda* however after completing additional review of plot data and plot photos, we believe that is highly unlikely. Care should be exercised on sites that are dominated by bluegrass species and further monitoring, including monitoring of control sites will be conducted to further explore this observation.

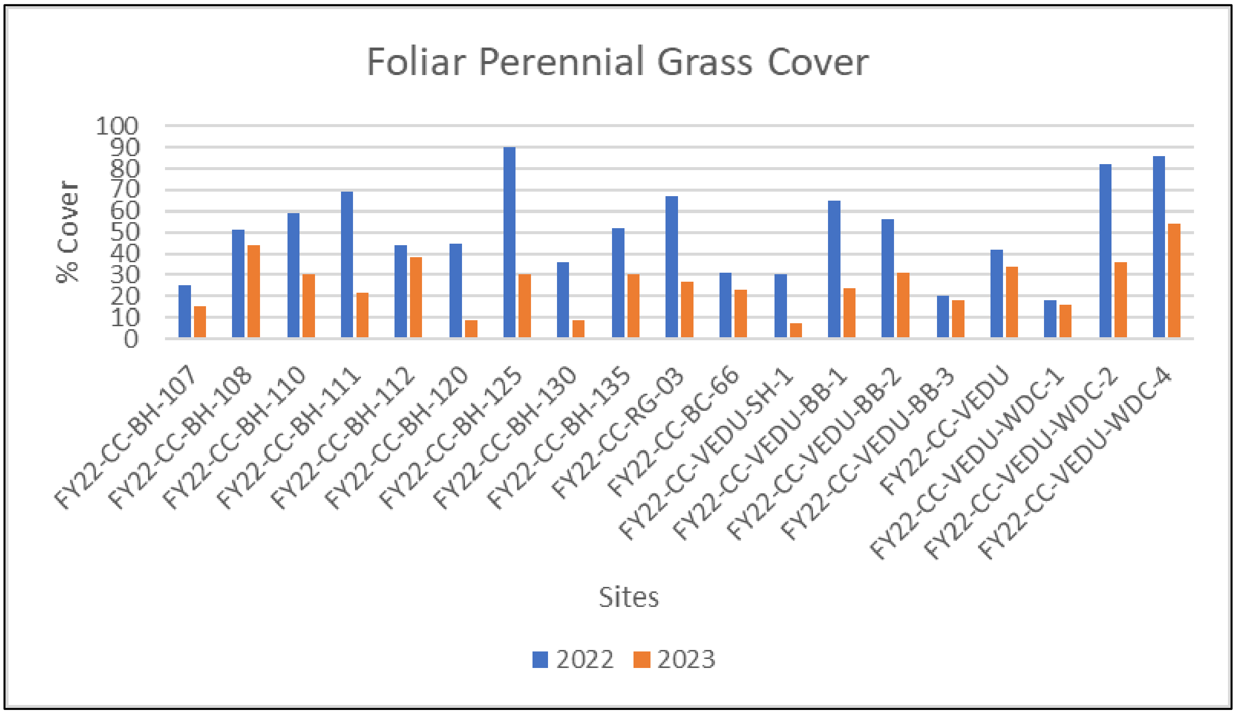

Figure 7: Perennial grass cover for all sites in 2022 and 2023.

Site Number	Percent Perennial Grass Cover 2022	Percent Perennial Grass Cover 2023	Percent Cover Change
FY22-CC-BH-107	25	15	-10
FY22-CC-BH-108	51	44	-6
FY22-CC-BH-110	59	30	-29
FY22-CC-BH-111	69	22	-47
FY22-CC-BH-112	44	38	-6
FY22-CC-BH-120	45	9	-36
FY22-CC-BH-125	90	30	-60
FY22-CC-BH-130	36	9	-27
FY22-CC-BH-135	52	30	-22
FY22-CC-RG-03	67	27	-40
FY22-CC-BC-66	31	23	-8
FY22-CC-VEDU-SH-1	30	7	-23
FY22-CC-VEDU-BB-1	65	24	-41
FY22-CC-VEDU-BB-2	56	31	-25
FY22-CC-VEDU-BB-3	20	18	-2
FY22-CC-VEDU	42	34	-8

Site Number	Percent Perennial Grass Cover 2022	Percent Perennial Grass Cover 2023	Percent Cover Change
FY22-CC-VEDU-WDC-1	18	16	-2
FY22-CC-VEDU-WDC-2	82	36	-46
FY22-CC-VEDU-WDC-4	86	54	-32
Mean	51.9	26.5	-25.4

Table 3: Foliar Perennial Grass Cover Percentage by site in 2022 and 2023 and the changes in cover following treatment. No density surveys were done for perennial grasses.

Forb Frequency/Cover Discussion

In 2022, forbs sweeps yielded an average of 13.4 species per site. This number decreased to 10.8 in 2023, and, while close to the 2022 average, was significant (P=.006). Average forb cover during the LPI survey also decreased, from 13.8 to 6.9 (P=.003) (Figure 8). This could be due to surveying later in the season when forb species are dying/already dead and harder to hit and/or identify. These general values also mask the following, more important trends. The percent of native forb species found during forb sweeps increased from 75.6 to 85.6 (P=.007). Frequency of native forbs (how many forb sweeps out of 25 a native species was found in) also increased from 82.2 to 85.4, although these values were not significant (P=.21) (Figure 9). Perennial forb increase was highly significant when looking at both total percent and frequency of perennial forb species (Figure 10). The former increased from 59.0 to 69.7 (P=.006) and the latter increased from 48.9 to 68.8 (P=.002).

Previously noted significant decreases in cheatgrass are potentially already allowing native forbs to return in greater numbers or reducing invasive forbs. There is a weak positive correlation (r=.21) from our data when comparing percent decrease in cheatgrass density and percent increase in native forb frequency (Figure 11).

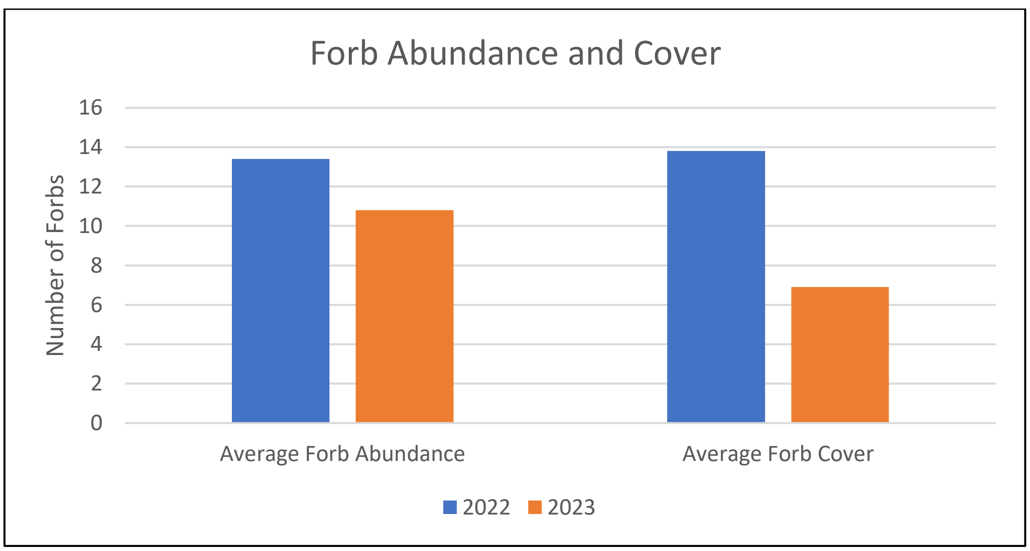

Figure 8: Average forb abundance (number of species) and average forb cover in 2022 and 2023.

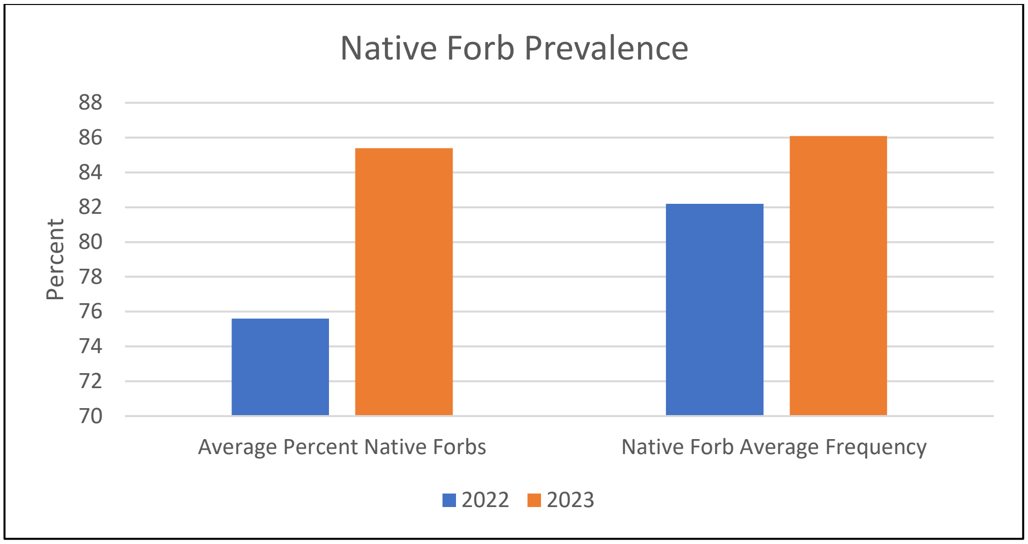

Figure 9: Average percent of identified forbs that were native and average frequency of native forbs in 2022 and 2023. Native forbs include both annuals and perennials.

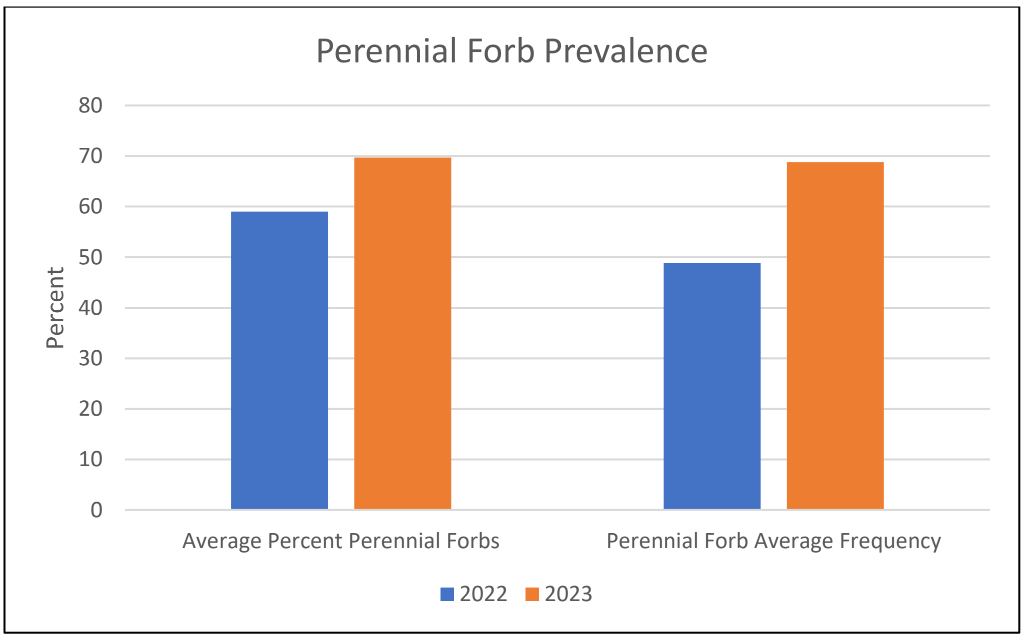

Figure 10: Average percent of identified forbs that were perennial and average frequency of perennial forbs in 2022 and 2023. Perennial forbs include both native and invasive species. Note difference in scale of Y-axis when compared to Figure 9.

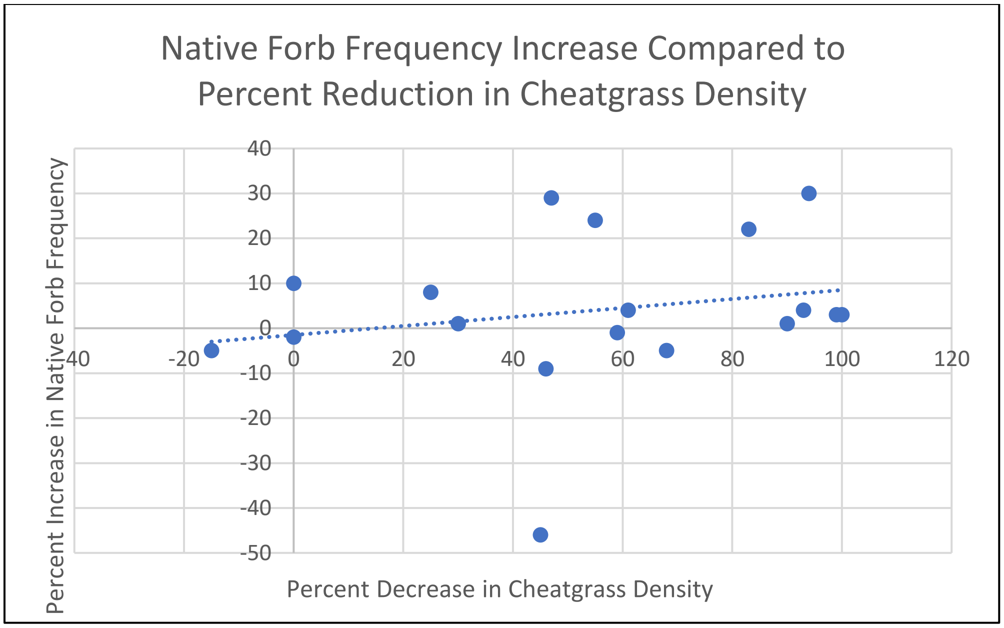

Figure 11: Scatterplot comparing percent decrease in cheatgrass density and percent increase in native forb frequency. Negative values on the X-axis indicate sites that increased in cheatgrass density. Negative values on the Y- axis indicate sites that saw a decrease in native forb frequency. Correlation coefficient (r) = .21.

Shrub Foliar Cover Discussion

The shrubs found in 2022 included low sagebrush (*Artemisia arbuscula* ssp. *longiloba*), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), antelope bitterbrush (*Purshia tridentata*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*), and dead shrubs of various species. Antelope bitterbrush and rubber rabbitbrush were the only species not hit during the 2023 surveys, but both were present at sites. There were no new species observed in 2023. In 2022, shrub cover ranged from 0-16% with an average of 4%. In 2023, shrub cover ranged from 0-28% with an average 5.3% (Figure 12). This increase was almost significant (P=.103). Since shrubs take longer to grow back than grasses and forbs, a smaller increase is to be expected. Given that shrub increase was not significant and that most sites have low or no cover, shrub cover is not analyzed further. However, since increases in shrub density is a long-term goal, we will continue to assess shrub cover through time.

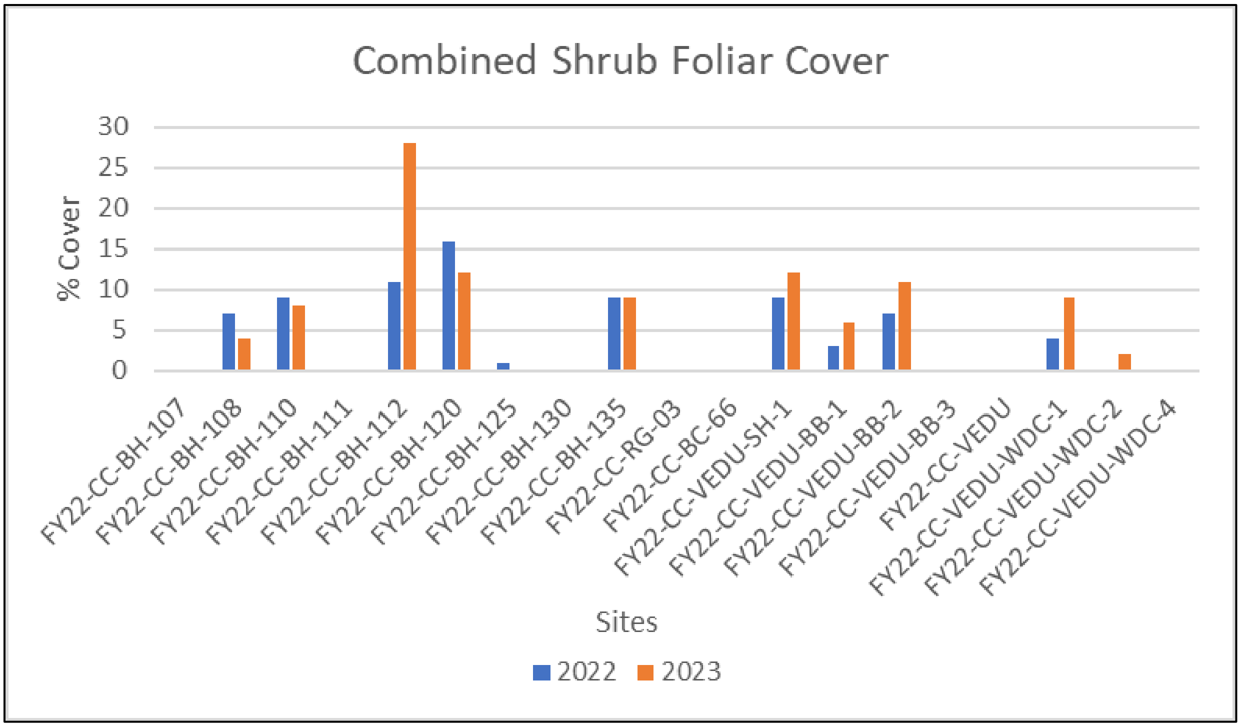

Figure 12: Foliar cover for all shrub species at all sites in 2022 and 2023.

Site Number	Percent Shrub Cover 2022	Percent Shrub Cover 2023	Percent Cover Change
FY22-CC-BH-107	0	0	NA
FY22-CC-BH-108	7	4	-3
FY22-CC-BH-110	9	8	-1
FY22-CC-BH-111	0	0	NA
FY22-CC-BH-112	11	28	+17
FY22-CC-BH-120	16	12	-4
FY22-CC-BH-125	1	0	-1
FY22-CC-BH-130	0	0	NA
FY22-CC-BH-135	9	9	0
FY22-CC-RG-03	0	0	NA
FY22-CC-BC-66	0	0	NA
FY22-CC-VEDU-SH-1	9	12	+3
FY22-CC-VEDU-BB-1	3	6	+3
FY22-CC-VEDU-BB-2	7	11	+4
FY22-CC-VEDU-BB-3	0	0	NA
FY22-CC-VEDU	0	0	NA
FY22-CC-VEDU-WDC-1	4	9	+5
FY22-CC-VEDU-WDC-2	0	2	+2
FY22-CC-VEDU-WDC-4	0	0	NA

Site Number	Percent Shrub Cover 2022	Percent Shrub Cover 2023	Percent Cover Change
Mean	4.0	5.3	+1.3

Table 4: Shrub cover at each site in 2022 and 2023 and the change in percent cover following treatment.

Ground Cover Discussion

Ground cover monitoring includes total surface cover and not canopy cover. In 2022, the most common ground hit was herbaceous litter at 35.8% cover on average. Average values for other ground cover types were 24.3% gravel, 21.8% bare soil, 8.9% rock, 2.1% moss, and 1.6% woody litter (Figure 13). Live vegetation hits were recorded as herbaceous or woody litter for the soil surface cover. In 2023, the most common ground hit was bare soil at 51.6% cover on average. Average values for other ground cover types were 19.3% herbaceous litter, 15.5% gravel, 7.2% rock, 4.5% moss, and .3 woody litter (Figure 13). The highly significant increase in bare soil and decrease in herbaceous litter (both $P<.001$) is likely due to interspaces opening after Rejuvra™ treatment reduced the ability of annual grasses to germinate. Reduced densities of targeted winter annual grasses that would have germinated in 2022 also would have decreased the amount of dead annual grasses (counted as herbaceous litter) in late summer 2023 when the surveys were done.

While significantly higher percentages of bare soil in 2023 indicate that Rejuvra™ is working to prevent new annuals from growing, the high percentages of herbaceous litter in 2022 may have impacted treatment effectiveness on some sites. Sites with lots of herbaceous litter may be less likely to see desired results because the herbicide does not make it into the soil as effectively. We compared percent decrease in cheatgrass density to percent herbaceous litter prior to treatment. Represented by a scatterplot (Figure 14), our data supports the hypothesized negative correlation between herbaceous litter and reduction in cheatgrass density with moderate to strong correlation ($r= -.47$). Sites with lower percentages of herbaceous litter tended to have higher percentages of cheatgrass reduction, as would be expected.

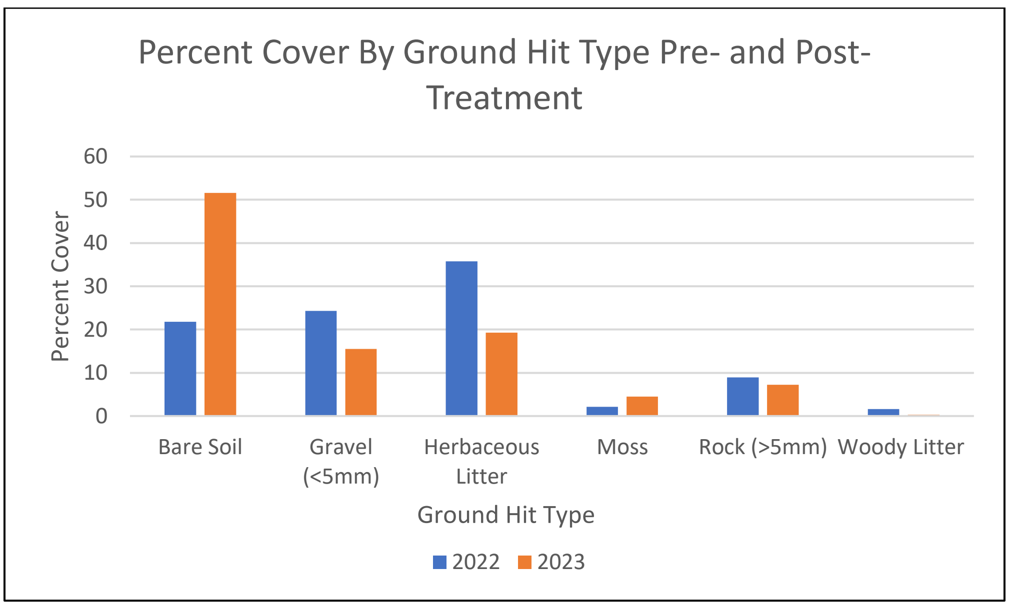

Figure 13: Average percent ground cover by type in 2022 and 2023.

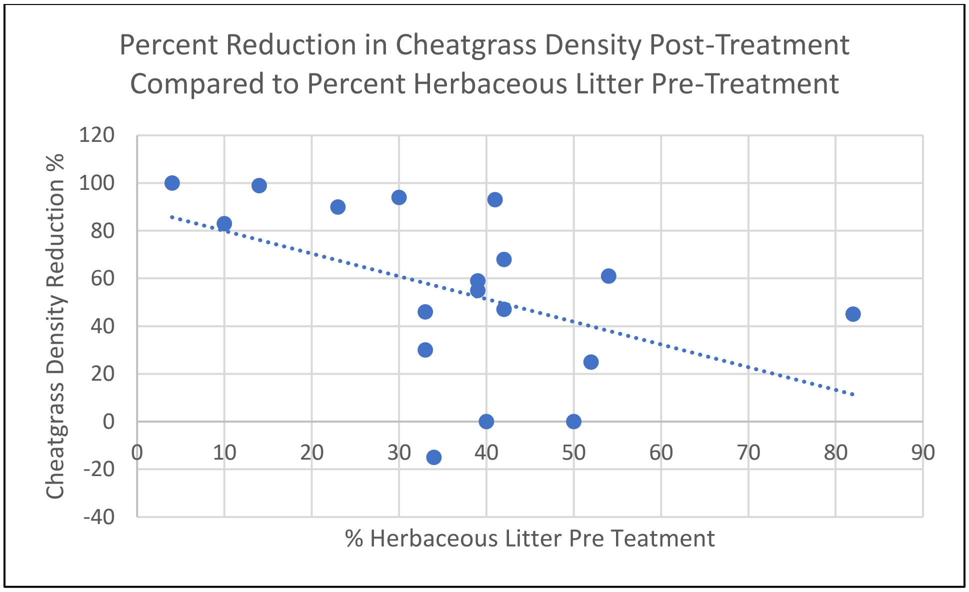

Figure 14: Scatterplot comparing percentages of herbaceous litter prior to treatment and reduction in cheatgrass density. Higher values on the Y-axis represent sites that saw greater decreases in cheatgrass and negative values represent sites that had increases in cheatgrass following treatment. Correlation coefficient (r) = -.47.

One site was excluded from this analysis due to cheatgrass increasing in density from 1.2 stems/m^2 to 4.4 stems/m^2. That would equate to an 267% increase even though the density only increased by 3.2 stems/m^2. Including that percentage would heavily skew data for values that are so small, they are almost negligible.

Most Improved and Least Improved Sites

Most improved and least improved sites for cheatgrass were chosen using ocular qualitative assessments of before and after treatment photos taken in each cardinal direction. The biggest consideration in these decisions was how much cheatgrass density *appeared* to decrease, regardless of the numbers. This method was chosen to compare our ocular estimates as resource professionals (qualitative analysis) to our transect data (quantitative analysis). Sites with the most visible cheatgrass decreases were ranked as the most improved and sites with the least noticeable decreases were ranked as the least improved sites. Sites whose primary target was wiregrass were not considered for this analysis. It should be noted that the least improved sites are not sites that necessarily became worse. Even on these sites, quantitative data shows there was still a fairly dramatic reduction of cheatgrass. Sites that looked "healthy" after treatment but had already started with low annual grass densities i.e. dominated by perennial species were not included in either group. Tables 5-6 show how important metrics compare across these sites.

When comparing the most improved and least improved sites where the main target was cheatgrass, there were significant differences in cheatgrass density decrease following treatment. The most improved sites saw greater decreases than the least improved sites (P=.051), however both groups still saw decreases. This supports what we witnessed at the sites and in subsequent plot photo review. Two other factors were found to have significant differences between groups. These were percent increase in native forb frequency following treatment and total herbaceous litter cover pretreatment (both P=.1). (The percent increase in perennial forbs between categories was not significant (P=.23)). This means that the most improved sites saw a greater increase in native forb frequency than the least improved sites. It also provides further support that herbaceous litter cover before treatment interferes with Rejuvra™ penetration because the least improved sites had significantly higher herbaceous litter cover pretreatment than the most improved sites. Herbaceous litter cover appears to be more important in determining Rejuvra™ penetration than the amount of bare soil exposed, as there was no significant difference in bare soil exposure prior to treatment between the two categories (P=.16). Additionally, there was no significant difference between decrease in perennial grasses when comparing the groups (P=.21). All of the most improved sites were on north-facing aspects. The least improved sites showed no consistent pattern regarding aspect. Slope was not a significant factor between categories (P=.63).

Most Improved Cheatgrass Sites	**Percent Decrease in Cheatgrass**	**Herbaceous Litter Cover Pretreatment**	**Slope/Aspect**	**Percent Increase in Native Forbs**
FY22-CC-BH-125	83	10	1, NW	22
FY22-CC-RG-03	68	42	20, NE	-5
FY22-CC-BH-108	59	39	5, NE	-1
FY22-CC-BH-112	47	42	5, NE	29
FY22-CC-BH-110	94	30	2, NE	30
Mean	70.2	32.6	/	15

Table 5: Important characteristics of most improved cheatgrass sites. The sites are ordered by how much they improved, with the most improved site at the top.

Least Improved Cheatgrass Sites	**Percent Decrease in Cheatgrass**	**Herbaceous Litter Cover Pretreatment**	**Slope/Aspect**	**Percent Increase in Native Forbs**
FY22-CC-BH-130	46	33	10, SE	-9
FY22-CC-BH-107	45	82	1, NE	-46
FY22-CC-BC-66	61	54	20, SW	4
FY22-CC-BH-135	55	39	6, NE	24
Mean	51.8	52	/	-6.8

Table 6: Important characteristics of least improved cheatgrass sites. The sites are ordered by how little they improved, with the least improved site at the top.

As for wiregrass, criteria for selecting the most improved and least improved sites was not based on site photos. Given that four of seven sites that had wiregrass before treatment had none after treatment, and that three sites had very high densities before treatment and low to no density after, we examined characteristics at the sites with the largest decreases to see if there were any common trends in physical characteristics. These were compared to sites that saw decreases that weren't as large or saw increases. Sites that had no wiregrass or small densities before treatment that went to zero after treatment were not included because they don't fit in either category. Whereas the above cheatgrass analysis looked at "what?" (what were the common trends between the most and least improved sites after treatment), it was more appropriate for the wiregrass analysis to look at "why?" (why did some sites see massive improvement and others didn't, based on pre-treatment data). The reason for the difference in analyses is that cheatgrass density decreases were relatively consistent but wiregrass density decreases were not.

Considering the sample sizes of the most improved and least improved groups were small (three and two, respectively) finding significant trends was limited. One significant result is that the most improved sites had far lower perennial grass cover in 2022 (P=.02). While lower perennial cover could be interpreted as less interception for Rejuvra™ and therefore higher Rejuvra™ contact with the soil surface, herbaceous litter and bare soil cover pretreatment (more direct metrics for Rejuvra™ interception and penetration) do not support this. Difference in herbaceous litter cover was not significant (P =.27). Difference in bare soil cover was almost significant (P=.11), but would have supported sites that improved having lower percentages of bare ground, rather than higher percentages. In reality, none of these results should be considered conclusive whether significant or not because it is generally not acceptable to interpret results from samples this small. To definitively determine trends between most improved and least improved sites, more sites with wiregrass need to be treated and surveyed. Given the high level of effectiveness that we observed with Rejuvra™ on most wiregrass sites, it is very possible that coverage, swath width, and droplet size are the variables that are of the most importance and not site or environmental variables.

Fire Regime and Frequency Effects

One of the challenges of managing sage-steppe landscapes that have become invaded by cheatgrass is preventing sites that are recovering from being burned in a much shorter fire return intervals. Restoration actions such as seeding and shrub planting can become unsuccessful when sites continue on burn on 5-10 year intervals instead of a more common interval of 50-75 years or longer. While we did not analyze or model the reduction in fire risk from treatments, the reduction in cheatgrass and opening of interstitial spaces should result in a reduction of potential for fire spread as well as improved ability of fire suppression resources to suppress fires as a result of decreased intensity. Future treatments should look at juxtaposition of habitats and potential for large fire spread when designing treatments to both reduce the potential for large fires and protect restoration investments on the landscape.

Complimentary Treatments

Long term goals are to reestablish desirable shrubs and suitable shrub cover on the landscape as well as reduce the negative effects of annual grasses, such as shortened fire return intervals. In some burned areas, the seed source for natural succession and establishment of shrubs is limited, especially if areas burned multiple times in a short time period. We addressed this in part by planting shrub seedlings pretreatment with the goal of establishing a seed source for natural regeneration (mother island seed concept). We have not noticed any effect of Indaziflam on planted shrubs and thus far appears to be a successful complimentary treatment although scale of plantings on the landscape is limited. We also began drill seeding bitterbrush and sagebrush in small pockets on the landscape and if we can get some establishment, a future Indaziflam treatment should release those plants. One of the challenges of Indaziflam is the limited ability to seed post treatment due to the residual nature of the herbicide. We are considering collecting soil samples to determine when Indaziflam levels in the soil have been reduced to allow reseeding as well as using other herbicides as a first treatment to allow seeding and then a future subsequent treatment of Indaziflam in future years. Developing successful techniques will be important in applying these treatments at a larger landscape scale and establishing desired vegetation to reduce potential soil erosion.

Data Limitations

Due to other projects, post-treatment cheatgrass surveys were completed later in the season than usual (two weeks to two months). This may have had an impact on surveyors being able to differentiate 2023's growth from previous years' growth. It also may have interfered with finding and/or properly identifying forbs in the survey. If so, the forb numbers in 2023 might be lower than they truly are. We did not resurvey our first year of spraying treatments due to time constraints however observations from the field indicate Indaziflam is still providing control of annual grasses in Year 2, as expected. Reading control plots in the future will be valuable in addition to the data collected before and after treatment however dedicating crew time to reading control plots on a yearly basis is not feasible at this time.

Recommendations and Future Needs

Data analysis and monitoring indicated that Rejuvra™ treatments on the Minidoka Ranger District have been successful in reducing cheatgrass, bulbous bluegrass, and wiregrass densities and returning plant communities to sites dominated by native perennial vegetation, in many cases the reduction in density has been dramatic. Results indicate that Rejuvra™ treatments can be used to begin addressing larger acreages of annual grasses with a higher probability of success than has been observed with other treatment strategies that have been used in the past. Data collection and analysis has also been helpful in developing an understanding of what sites to treat and how to best apply these treatments as well as begin the implementation of the adaptive management cycle and scale up treatments. Collecting data in Year 3 (2025) and Year 5 (2027) for treated areas and continuing treatment through the lifespan of the project will be critical to complete a thorough evaluation of treatment effectiveness through time, seed bank dynamics and the overall functional persistence of Indaziflam in the soil. Additionally, continued monitoring and treatment will provide a roadmap for how to develop a long-term, large-scale treatment plan that effectively reduces cheatgrass and wiregrass dominance and provides quality habitat at a meaningful scale for target species like sage-grouse and mule deer, for both the Sawtooth National Forest and other land managers.

Some of the key lessons learned so far for this project include:

- Indaziflam application can be a very effective stand-alone annual grass treatment on sites that still have a deep rooted native perennial bunchgrass community,
- Indaziflam reduces annual grasses in interstitial spaces very effectively, thereby reducing fuel continuity on the landscape and making plant communities less fire prone.
- Try to spray Indaziflam before any precipitation occurs that would start fall green-up or consider a tank mix. Spraying in mid-season (June through August) is emerging as a recommendation. Work with a representative for Rejuvra™ to best determine timing for your site.
- On sites with excessive litter, consider utilizing grazing as a complimentary treatment to reduce canopy interception of the herbicide and maximize effectiveness.
- Consider planting shrub seedlings in the fall prior to treatment with Indaziflam. Consider utilizing a tree planter in areas of heavier cheatgrass cover to reduce competition and increase seedling survival for the growing season prior to treatment.
- Consider using a Imazapic/Aminopyralid tank mix on sites where *Poa secunda* is the dominant perennial grass rather than Indaziflam due to the potential for increased injury to *Poa secunda*.
- Implement grazing management and rest during the growing season of perennial bunchgrasses in treated sites, with an emphasis placed on sites that are dominated by annual grasses. Ensuring desirable native plant species increase in vigor and composition is critical to increasing resistance to invasive species and long-term resiliency of the site to future disturbance events.
- Consider multiple site entries with herbicide mixes such as an Imazapic/Aminopyralid tank mix to treat sites dominated by cheatgrass, where deep rooted perennial grass cover is low and then utilize aerial seeding in the fall after treatment.
- If aerial seeding is completed post herbicide application, consider using livestock to work seeds into soil to increase seed/soil contact and improve germination rates.
- With Indaziflam treatments, bare soil and erosion potential could become a concern on annual grass monoculture sites or annual grass sites on steeper slopes. Consider if Indaziflam is the right tool on monoculture type sites or if a different herbicide mix would be more well suited to meet

project objectives. Utilize industry technical specialists to develop a treatment plan as project activities are scaled up and complexities increase.

- Recognize that Indaziflam will be a barrier to seeding post treatment and recommendations on how to seed into Indaziflam treated areas are still being developed.
- Try to utilize contractors with experience with Rejuvra™ and proven success. Emphasize the importance of droplet size, swatch width, and ensuring uniform coverage within treatment areas.
- Ensure helicopter typing is well suited for the terrain being treated. Steeper slopes and canyons that are more common on USFS lands may require a different helicopter than what can be used on flatter landscapes with less terrain.
- Utilize drip/drift cards for monitoring and feedback to contractors during project implementation.

Developing an Annual Grass Restoration Program

Successfully restoring habitat impacted by cheatgrass as well as breaking the cheatgrass fire cycle is going to require treatments at spatially relevant landscape scales. To begin to address larger landscapes and at the scale necessary to address annual grass effects, working in sites dominated or co-dominated by cheatgrass is going to be necessary. Due to the effectiveness of Indaziflam and the residual action of the herbicide, there is some concern regarding utilizing it on larger acreages of cheatgrass dominated sites where perennial plants are in very low densities, especially in areas with steeper slopes.

Implementing a restoration program that relied too heavily on one tool is likely going to produce subpar results or will prove challenging in attempting to successfully tie treatments into one another at a spatially relevant scale for managers. Use of other herbicides such as Aminopyralid and Imazapic, perennial bunchgrass seeding on monoculture sites to increase the establishment of perennial plants post treatment, prescriptive grazing, fuel breaks to protect investments, and other complementary treatments and tools will need to be incorporated into treatment plans to have success at the larger landscape scale that is desired.

For future large-scale spraying, contractor selection is a key component of a project's success. Rejuvra™ is a newer herbicide and contractors who have demonstrated prior success in using it in more rugged rangeland environments should be a contract evaluation factor. There were several sites in this study where patchy/ineffective application was apparent. After reviewing post treatment GPS data and field data results, we believe this may be due to droplet size and/or swatch width that contributed to a lack of uniform coverage. The use of drip/drift cards is recommended for all treatments regardless of contractor selection. These cards act as a litmus test for herbicide application. They are useful in analyzing and interpreting future results by providing tangible correlations between treatment and results, as well as providing real time feedback to contractors if there was an issue with application.

Ineffective and patchy herbicide application may also be the result of canopy cover in some sites, rather than contractor experience, swath width or droplet size. Sites with higher densities of herbaceous litter, sagebrush, and juniper may be less likely to see herbicide effectiveness because the chemical will have a harder time reaching and penetrating the soil surface. This was directly observed on FY22-CC-BH-125 (reference photo below) where annual grass decreased everywhere except in the shadow of a dead juniper, remaining similar to densities in pre-treatment photos. On sites with high amounts of herbaceous litter, managers should consider utilizing grazing before treatment to reduce herbicide interception. This will require Forest Service grazing managers working with livestock permittees to allow flexible grazing plans on allotments where treatment is planned.

Some sites may need to be resprayed with Rejuvra™ if low effectiveness is evident on a site two years after application for the reasons listed above. To determine respraying criteria, we looked at several different factors in our sites including percent decrease in cheatgrass density, before and after photos, and plant dominance. By comparing pre- and post-treatment photos to post-treatment cheatgrass densities at the sites with varying levels of improvement, we determined that cheatgrass densities under 100 stems/m^2 following treatment are acceptable and do not need to be resprayed. If densities are over 100 stems/m^2, a few more factors should be considered when determining whether to respray. Sites that are dominated by perennial grasses and/or shrubs (based on cover percentages) do not need to be prioritized for retreatment. Sites with more than 100 cheatgrass steams/m^2 that are also cheatgrass dominant should be resprayed if their initial cheatgrass densities are higher than 500 stems/m^2 and if the percent decrease in cheatgrass density following the first treatment is less than 50%. These criteria can also be applied if respraying for wiregrass. This is a recommendation based on the results of this study and our professional judgement and may not be accurate for all sites. Surveyor discretion and on-site verification should be used in cases where results are close to the above values. Practitioners should recognize that in many cases, respraying does not need to include the entire treatment polygon but rather a smaller subset within initial treatment polygons. Respraying treatments should always be field verified and mapped to maintain the cost effectiveness of a treatment program. In the future, respraying with drones may prove to be a more efficient way to address smaller areas of retreatment.

Data from this study strongly supports a potential negative effect on the species *Poa secunda*. This grass was the most common native perennial bunchgrass across all sites before treatment and saw a drastic reduction in cover after treatment. This reduction is too significant to suggest surveyor error. A possible explanation is that *Poa secunda's* relatively shallow roots make it susceptible to injury from Rejuvra™. We hypothesized that other bunchgrasses that were found to have insignificant changes in cover have deeper roots and are less likely to be affected by Rejuvra™. Future surveys should pay close attention to *Poa secunda* to determine if Rejuvra™ is in fact causing declines and what casual factors may be causing the decline.

Consistent, accurate, and repeatable data will be critical for best results. Using GPS points on Avenza Maps and pre-treatment site photos, resample locations in 2023 were as close as possible to original locations. These however, are not always accurate due to gps location accuracy, changes in the landscape following treatment, and lack of significant landmarks in reference photos. LPI monitoring does not require exact precise re-reads on the transect line to be statistically valid however future cheatgrass pre-treatment surveys would benefit from a having a permanent marker placed at the beginning and end of the transect to maximize accuracy of post-treatment surveys. Additionally, it will be important to read control plots in the future to compare the long-term control of annual grasses and changes in plant community composition between treated and untreated and account of variation in plant communities. Indaziflam treatments are showing control of annual grasses in Year 1 and 2 and we believe it is likely that no further treatment will be needed on many sites however it is too soon to assess the long-term effects on plant community composition.

Moving forward, it will be important for the Forest Service to continue to partner and actively work with state agencies, NGO's, livestock permittees, and other stakeholders to continue to develop treatment and expand efforts to reduce annual grass dominated plant communities at spatially relevant scales as well as ensuring treatments are occurring in areas where investment of limited dollars will provide the most benefits. The pooling of resources and funding to implement treatments across the landscape, as well as a multi-agency approach to identifying the areas with the highest resource and ecological value has been a success and should continue in the future.

Upcoming Treatments

The Sawtooth National Forest and partners are planning on increasing the scale of treatments in 2024 to approximately 6,500 acres of aerial treatment utilizing Indaziflam on some sites and a tank mix of Aminopyralid and Imazapic (Milestone™ and Plateau™) on other sites. Complimentary treatments will likely include prescriptive grazing, seeding, and shrub planting. Intensive monitoring will continue to assess the success of the project and implement adaptive management changes as necessary.

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Appendix A: Treatment Area Maps

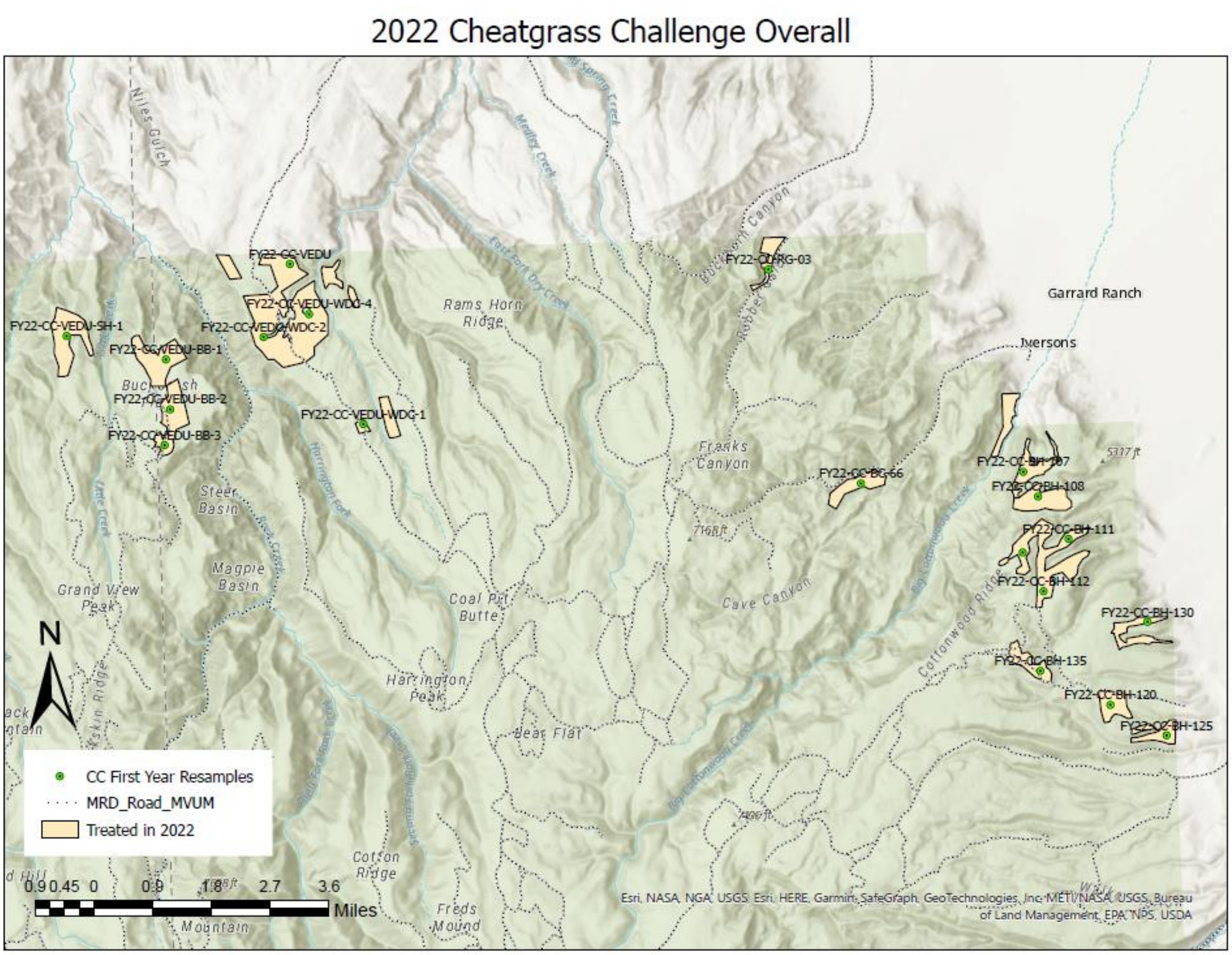

Figure 15: Overall Cheatgrass Site Map.

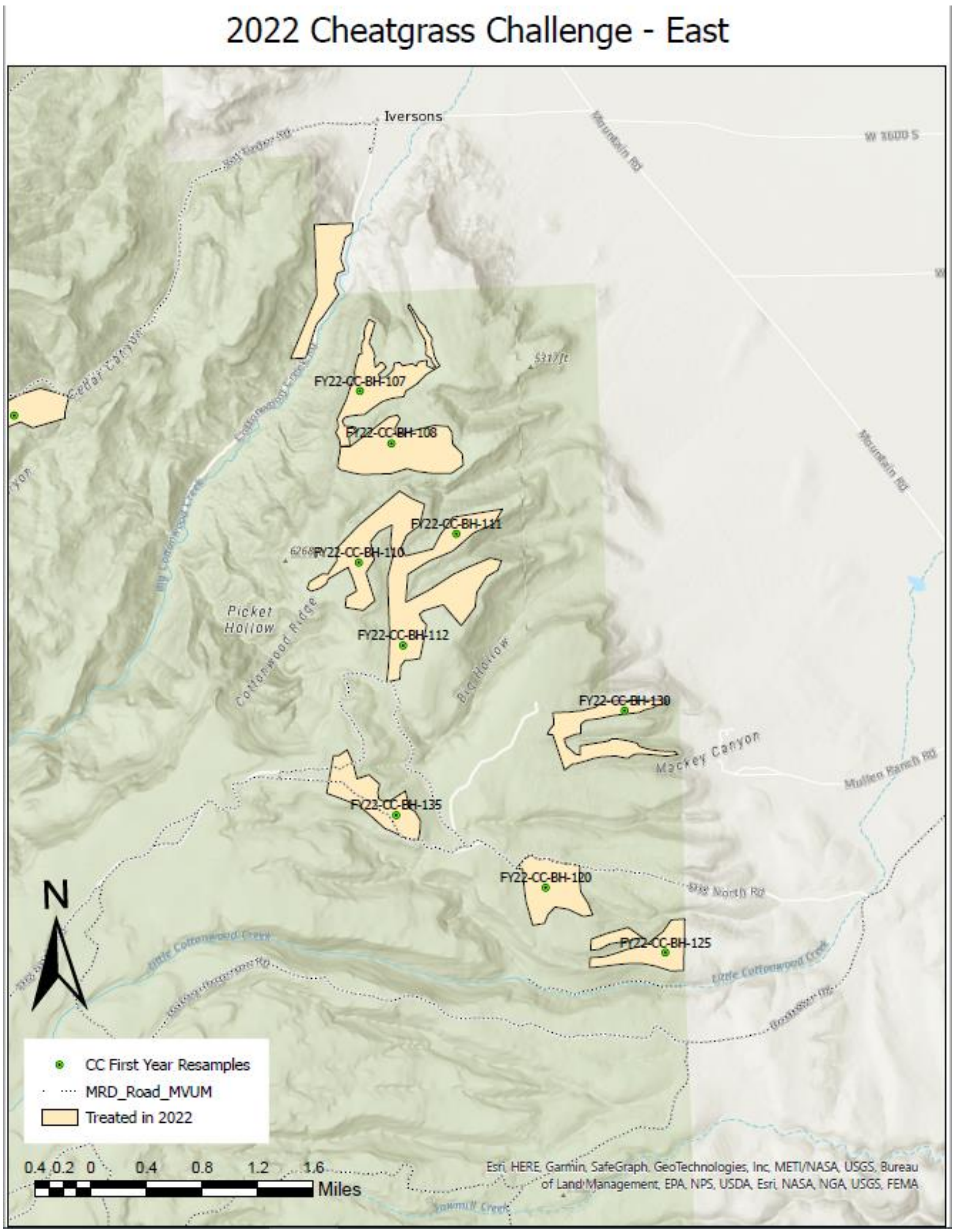

Figure 16: Sites within the vicinity of Big Hollow.

2022 Cheatgrass Challenge - East

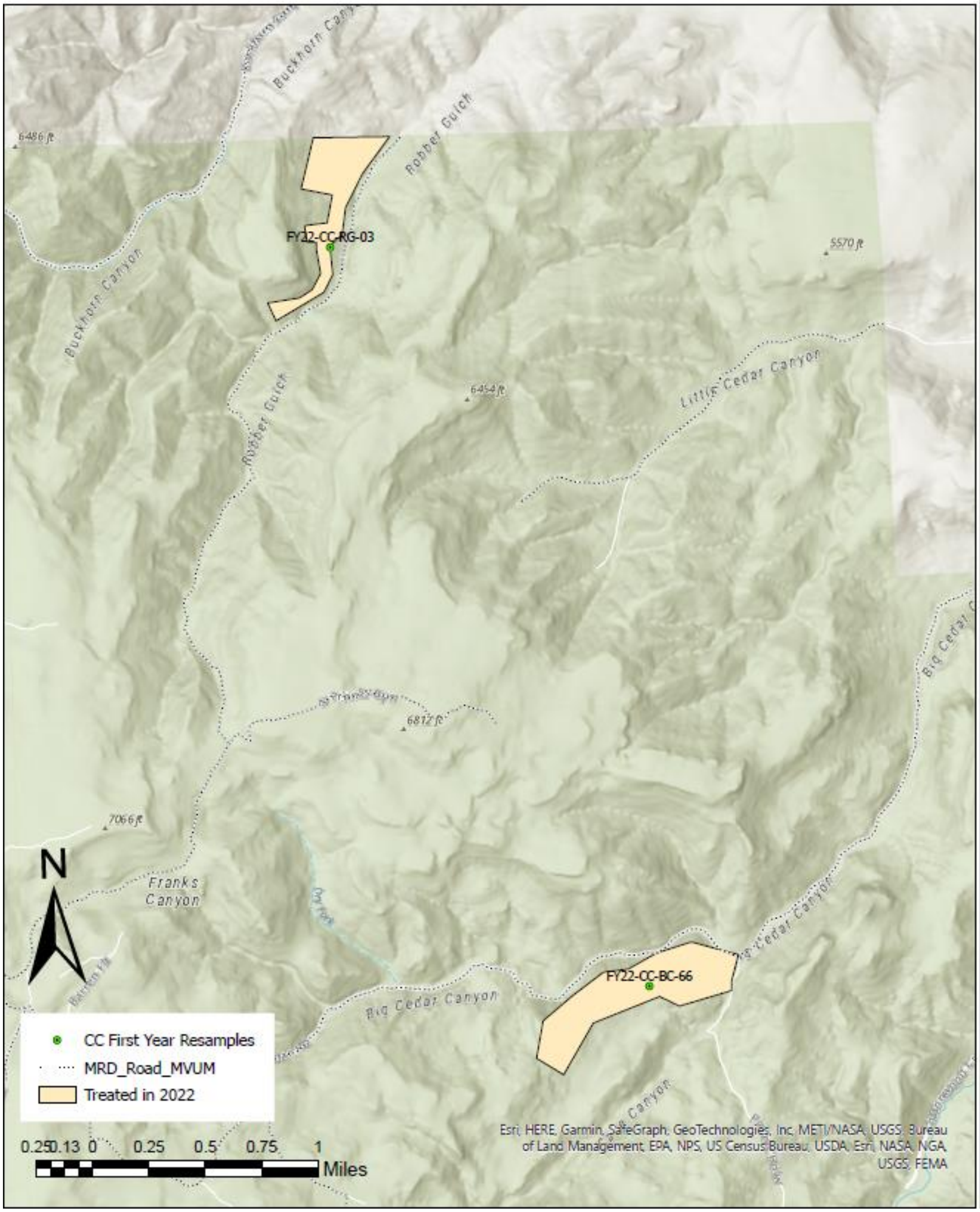

Figure 17: Sites within the vicinity of Big Cottonwood and Robber Gulch.

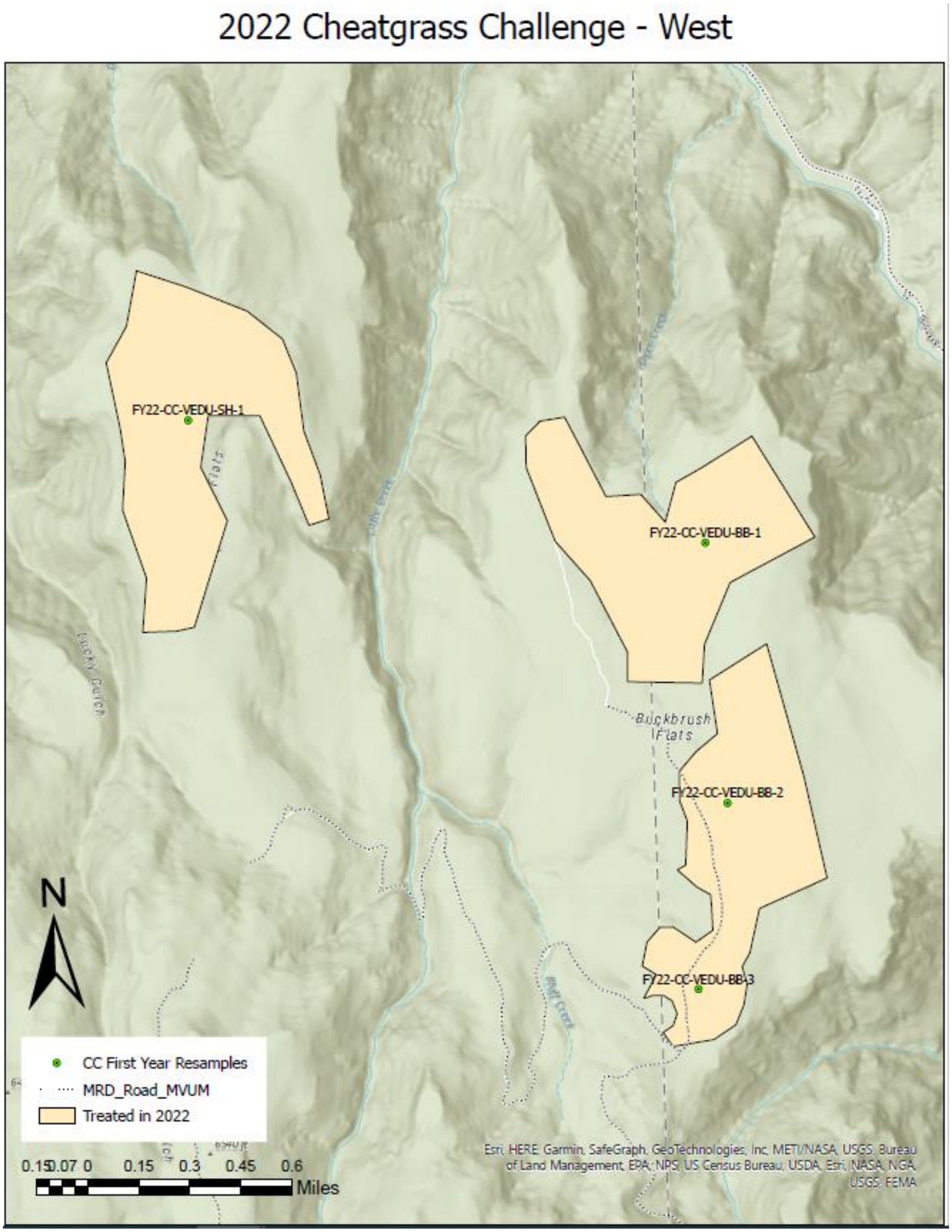

Figure 18: Sites within the vicinity of Buckbrush Flats.

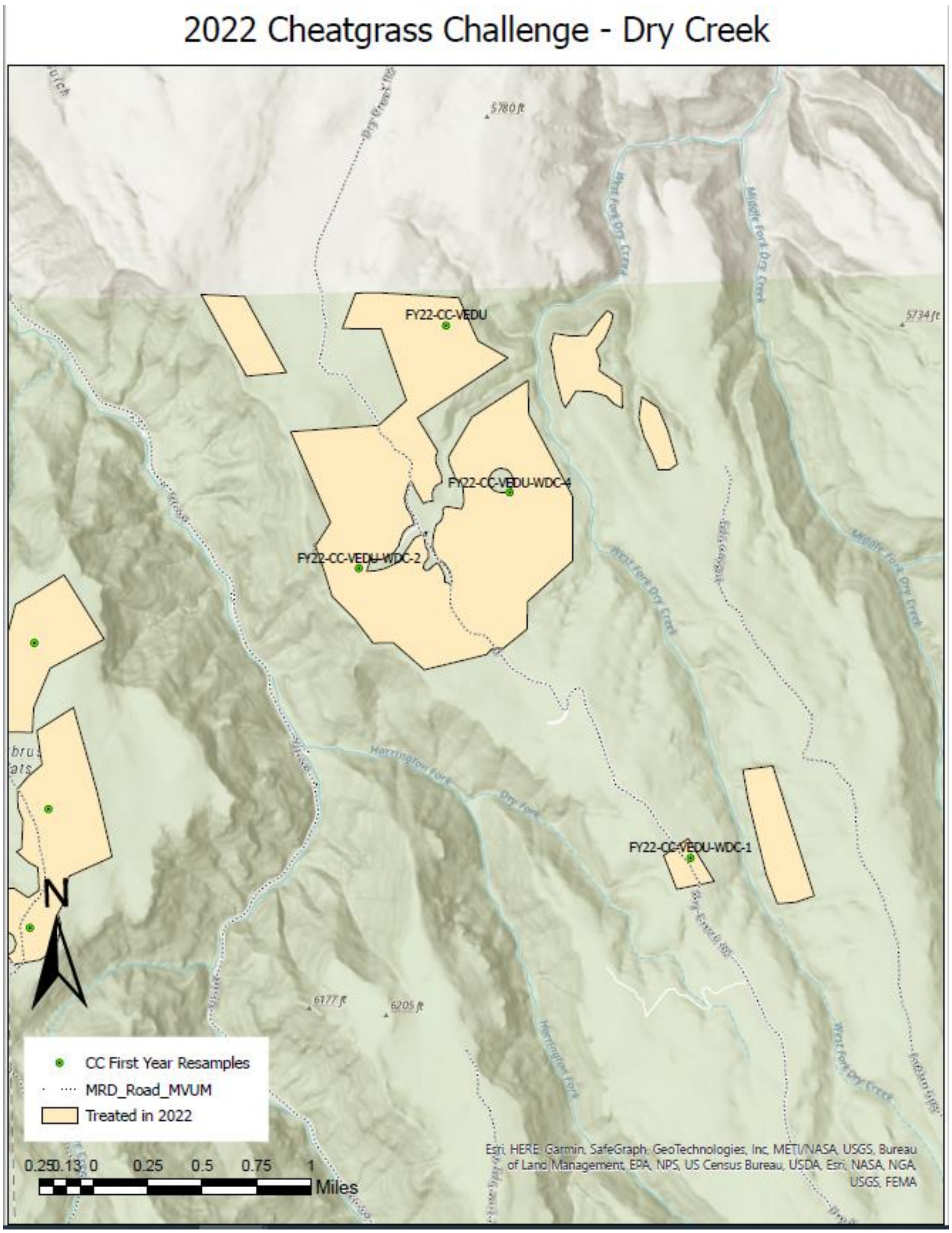

Figure 19: Sites within the vicinity of Dry Creek.

Appendix B: Site Data Analysis and Plot Photos

Photo 1: FY22-CC-BH-107, 7/2/22 (above)

Photo 2: FY22-CC-BH-107, 8/30/23 (left)

Overall cheatgrass density at this site decreased by 45% (1,464.4 plants/m^2), with 3251.6 plants/m^2 in 2022 and 1787.2 plants/m^2 in 2023. Cheatgrass cover decreased by 28% (79% to 51%) and perennial grass cover decreased by 10% (25% to 15%) one year after treatment. There was no shrub cover in either year. Most of the ground cover in 2022 was herbaceous litter at 82%. In 2023, herbaceous litter is at 30% and bare soil makes up the majority at 57%.

The 2023 resample was taken slightly SW of the original point (see plot photos). Due to initial and continued cheatgrass prevalence and dominance at this site, we recommend evaluating this site for respraying. The high levels of herbaceous litter prior to treatment may have been a factor in its lower effectiveness at this site.

Photo 3: FY22-CC-BH-108, 6/30/22 (above)

Photo 4: FY22-CC-BH-108, 8/30/23 (left)

Overall cheatgrass density at this site decreased by 59% (67.2 plants/m^2), with 114.8 plants/m^2 in 2022 and 47.6 plants/m^2 in 2023. Cheatgrass cover decreased by 13% (17% to 4%) and perennial grass cover decreased by 7% (51% to 44%) one year after treatment. Shrub cover decreased by 3% (7% to 4%). The majority of ground cover in 2022 was herbaceous litter at 39% and gravel at 37%. In 2023, herbaceous litter is at 7%, gravel is at 31%, and bare soil makes up the majority at 62%.

Cheatgrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

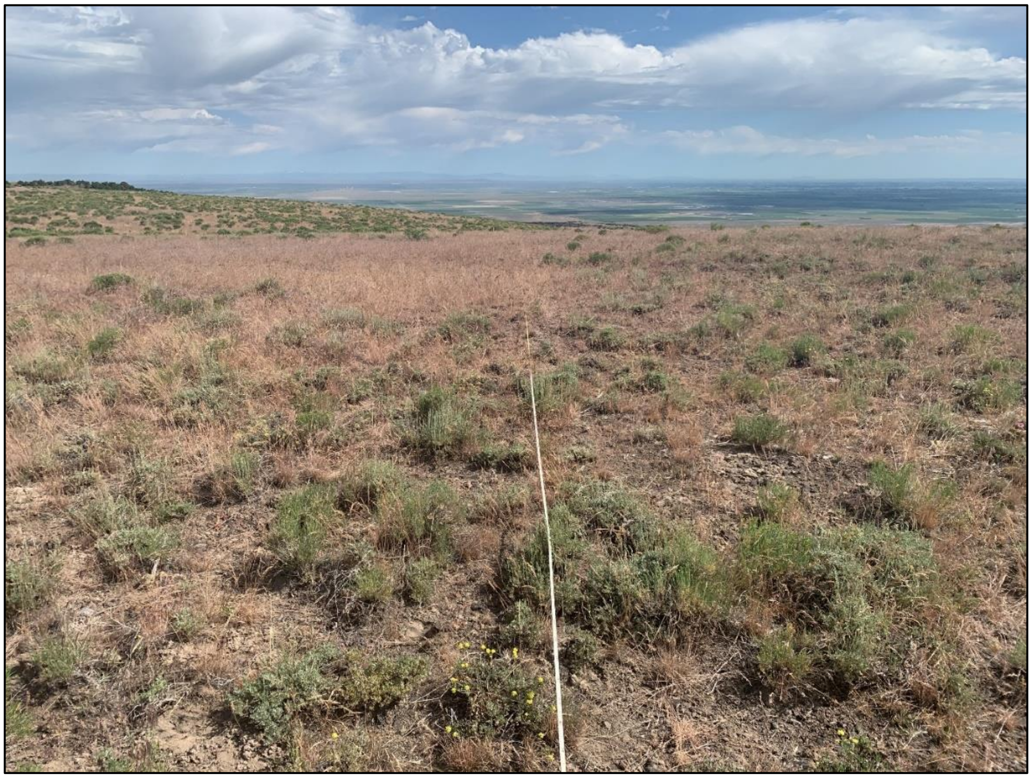

Photo 5: FY22-CC-BH-110, 6/30/22 (above)

Photo 6: FY22-CC-BH-110, 8/30/23 (left)

Overall cheatgrass density at this site decreased by 94% (58 plants/m^2), with 62 plants/m^2 in 2022 and 4 plants/m^2 in 2023. Cheatgrass cover decreased by 8% (10% to 2%) and perennial grass cover decreased by 29% (59% to 30%) one year after treatment. Shrub cover decreased by 1% (9% to 8%). Ground cover in 2022 was almost evenly split between bare soil, gravel, and herbaceous litter. In 2023, bare soil and gravel cover increased while herbaceous litter cover decreased.

Cheatgrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

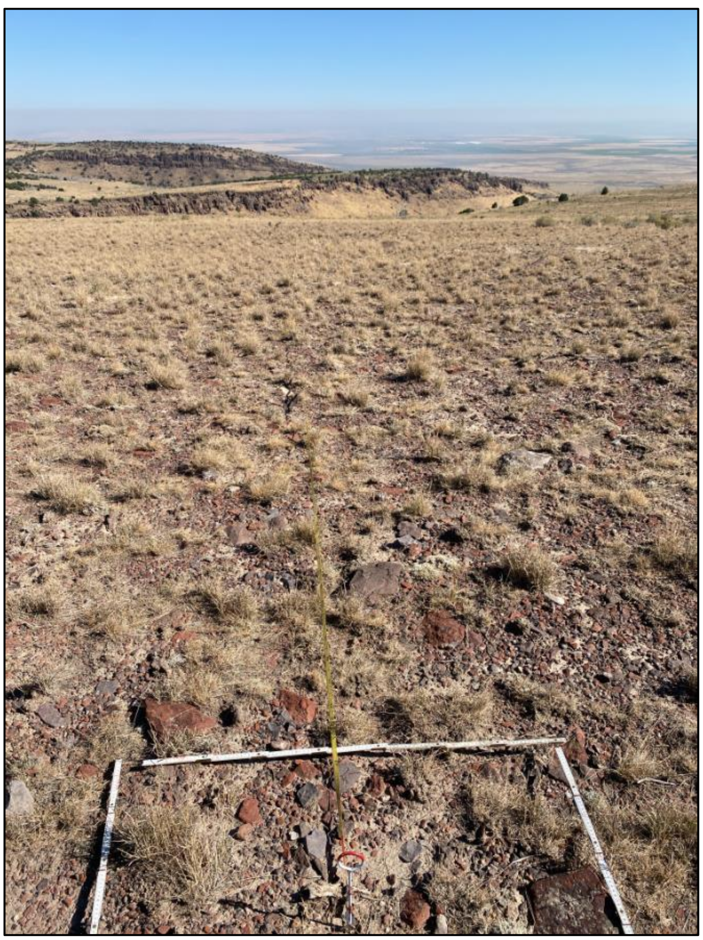

Photo 7: FY22-CC-BH-111, 6/30/22 (above)

Photo 8: FY22-CC-BH-111, 8/31/23 (left)

Overall cheatgrass density at this site decreased by 99% (88.4 plants/m^2), with 89.6 plants/m^2 in 2022 and 1.2 plants/m^2 in 2023. Cheatgrass cover decreased by 12% (13% to 1%) and perennial grass cover decreased by 47% (69% to 22%) one year after treatment. There was no shrub cover in either year. The majority of ground cover in 2022 was herbaceous litter at 62%. In 2023, herbaceous litter is at 6% and bare soil makes up the majority at 55%.

Cheatgrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

Photo 9: FY22-CC-BH-112, 6/30/22 (above)

Photo 10: FY22-CC-BH-112, 8/31/23 (left)

Overall cheatgrass density at this site decreased by 47% (50.8 plants/m^2), with 107.6 plants/m^2 in 2022 and 56.8 plants/m^2 in 2023. Cheatgrass cover decreased by 20% (22% to 2%) and perennial grass cover decreased by 6% (44% to 38%) one year after treatment. Shrub cover more than doubled, going from 11% in 2022 to 28% in 2023. The majority of ground cover in 2022 was almost evenly split between bare soil (45%) and herbaceous litter (42%). In 2023, bare soil cover increased to 83% while herbaceous decreased to 10%.

Cheatgrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

Photo 11: FY22-CC-BH-120, 6/30/22 (above)

Photo 12: FY22-CC-BH-120, 8/23/23 (left)

Overall cheatgrass density at this site decreased by 25% (60.8 plants/m^2), with 247.6 plants/m^2 in 2022 and 186.8 plants/m^2 in 2023. Cheatgrass cover decreased by 6% (25% to 19%) and perennial grass cover decreased by 34% (45% to 9%) one year after treatment. Shrub cover decreased by 4% (16% to 12%). The majority of ground cover in 2022 was herbaceous litter at 52%. In 2023, herbaceous litter is at 18% and bare soil makes up the majority at 59%.

While having more than 100stems/m^2 and being cheatgrass dominated, initial cheatgrass densities were low enough that the site does not need to be resprayed.

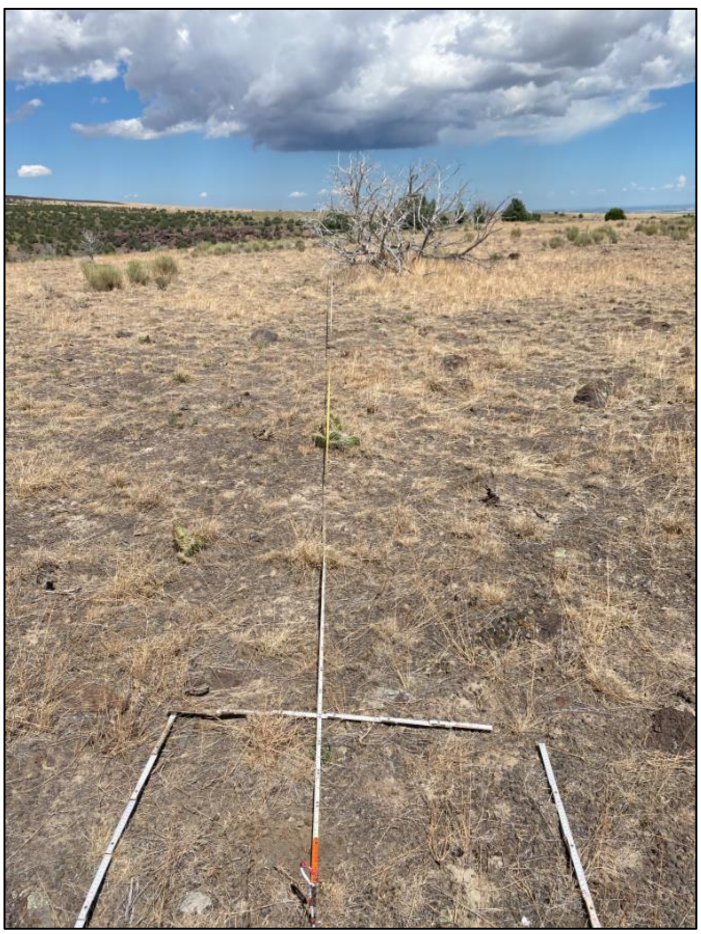

Photo 13: FY22-CC-BH-125, 7/1/22 (above)

Photo 14: FY22-CC-BH-125, 8/23/23 (left)

Overall cheatgrass density at this site decreased by 83% (353.9 plants/m^2), with 426.4 plants/m^2 in 2022 and 72.5 plants/m^2 in 2023. Cheatgrass cover decreased by 9% (21% to 12%) and perennial grass cover decreased by 60% (90% to 30%) one year after treatment. Shrub cover decreased by 1% (1% to 0%). The majority of ground cover in 2022 was gravel at 67%. In 2023, gravel is at 20% and bare soil makes up the majority at 70%.

Cheatgrass density post- treatment fell within acceptable range; therefore site does not need to be resprayed.

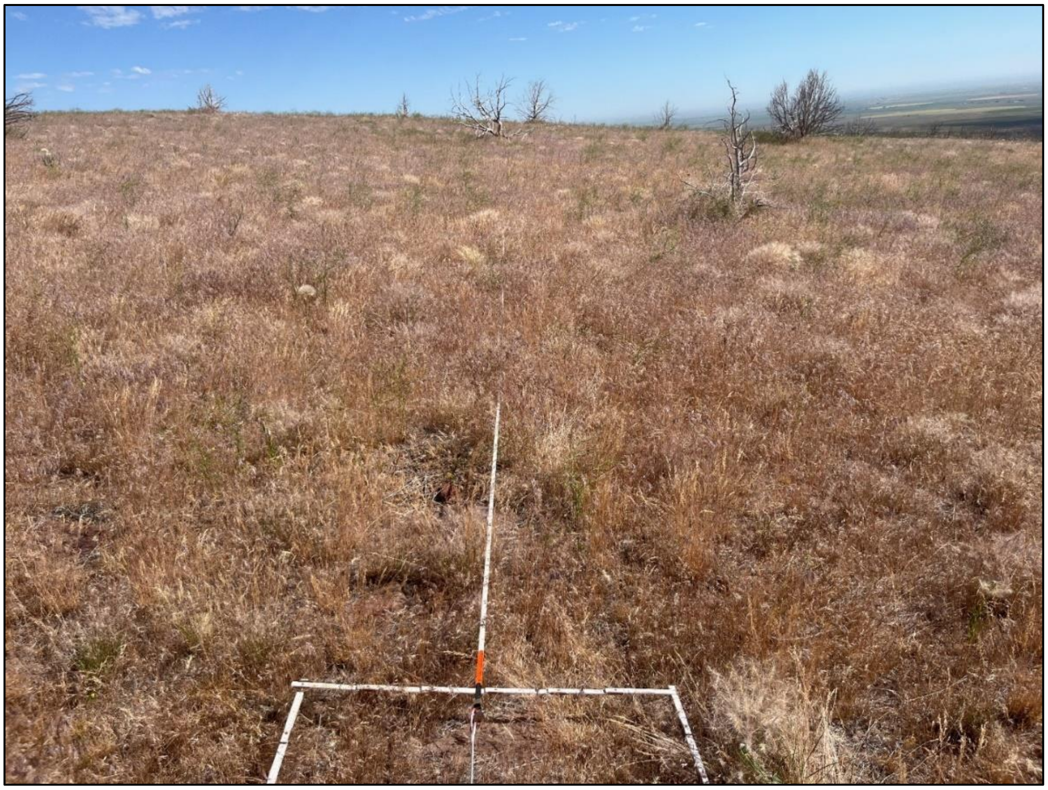

Photo 15: FY22-CC-BH-130, 7/1/22 (above)

Photo 16: FY22-CC-BH-130, 8/31/23 (left)

Overall cheatgrass density at this site decreased by 46% (877.2 plants/m^2), with 1897.2 plants/m^2 in 2022 and 1020 plants/m^2 in 2023. Cheatgrass cover decreased by 33% (71% to 38%) and perennial grass cover decreased by 27% (36% to 9%) one year after treatment. There was no shrub cover in either year. The majority of ground cover in 2022 was split between gravel at 46% and herbaceous litter at 33%. In 2023, gravel is at 20%, herbaceous litter is at 19%, and bare soil makes up the majority at 58%.

This site should be evaluated for respraying due to high densities of cheatgrass before and after treatment. Additionally, grazing should be closely managed in this treatment area when retreated in the future due to the low overall density of perennial grasses. Perennial plants will need to not be grazed during the critical growth period.

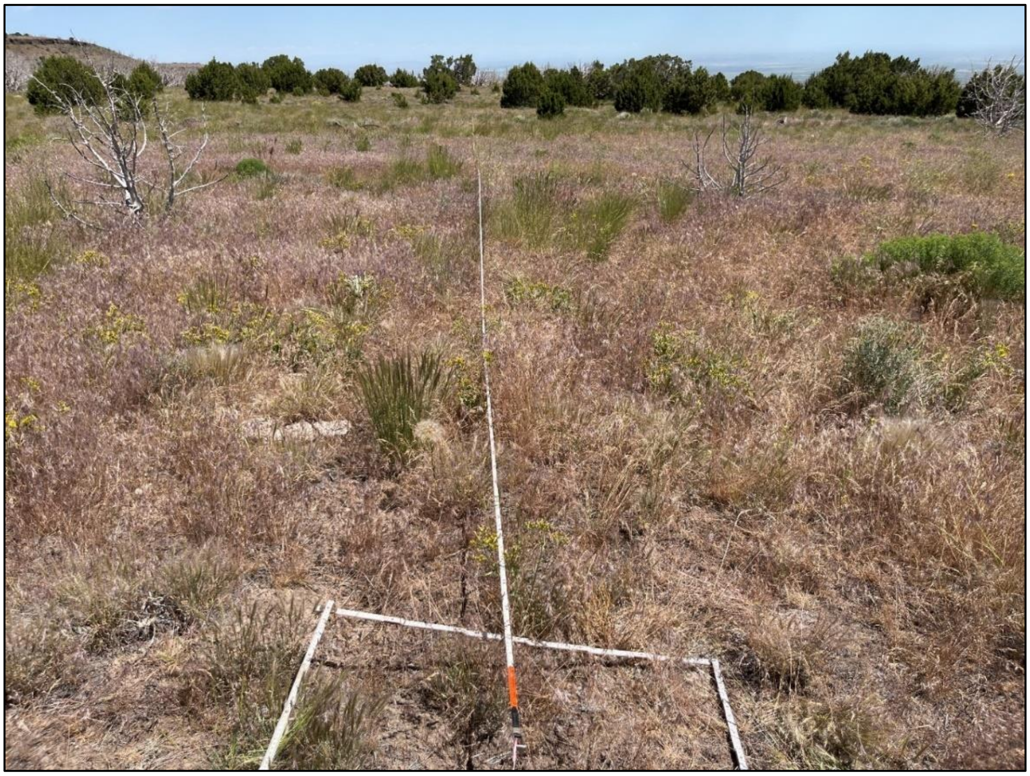

Photo 17: FY22-CC-BH-135, 7/1/22 (above)

Photo 18: FY22-CC-BH-135, 8/23/23 (left)

Overall cheatgrass density at this site decreased by 55% (423.6 plants/m^2), with 768 plants/m^2 in 2022 and 344.4 plants/m^2 in 2023. Cheatgrass cover decreased by 17% (39% to 22%) and perennial grass cover decreased by 22% (52% to 30%) one year after treatment. Shrub cover remained the same in both years at 9%. The majority of ground cover in 2022 was split between herbaceous litter at 39%, gravel at 27%, and bare soil at 24%. In 2023, herbaceous litter decreased to 21%, gravel decreased to 17%, and bare soil increased to 49%.

While cheatgrass density is still higher than desired target levels, perennials dominate the site, so it does not need to be resprayed.

Photo 19: FY22-CC-RG-03, 7/12/22 (above)

Photo 20: FY22-CC-RG-03, 8/24/23 (left)

Overall cheatgrass density at this site decreased by 68% (3278.8 plants/m^2), with 4850 plants/m^2 in 2022 and 1571.2 plants/m^2 in 2023. Cheatgrass cover decreased by 51% (79% to 28%) and perennial grass cover decreased by 40% (67% to 27%) one year after treatment. There was no shrub cover in either year. The majority of ground cover in 2022 was split between gravel at 46% and herbaceous litter at 42%. In 2023, gravel decreased 16% herbaceous litter increased to 46%.

This site does not need to be resprayed due to high reduction in cheatgrass densities following first treatment.

Photo 21: FY22-CC-BC-66, 7/14/22 (above)

Photo 22: FY22-CC-BC-66, 8/24/23 (left)

Overall cheatgrass density at this site decreased by 61% (3634.9 plants/m^2), with 6001.3 plants/m^2 in 2022 and 2366.4 plants/m^2 in 2023. Cheatgrass cover decreased by 4% (70% to 66%) and perennial grass cover decreased by 8% (31% to 23%) one year after treatment. There was no shrub cover in either year. The majority of ground cover in 2022 was split between herbaceous litter at 54% and gravel at 37%. In 2023, herbaceous litter increased to 60% and gravel decreased to 24%.

Despite data for this site suggesting it does not need to be sprayed, cheatgrass densities are still high enough that the site should be considered for being resprayed.

 

Photo 23: FY22-CC-VEDU-SH-1, 8/11/22 (left)

Photo 24: FY22-CC-VEDU-SH-1, 8/29/23 (right)

Overall cheatgrass density at this site decreased by 90% (22.4 plants/m^2), with 24.8 plants/m^2 in 2022 and 2.4 plants/m^2 in 2023. Wiregrass density decreased by 100% from 5689 plants/m^2 in 2022 to 0 plants/m^2 in 2023. Cheatgrass cover decreased by 1% (1% to 0%), wiregrass cover decreased by 84% (84% to 0%), and perennial grass cover decreased by 23% (30% to 7%) one year after treatment. Shrub cover increased by 3% (9% to 12%). The majority of ground cover in 2022 was split between bare soil at 35%, rock at 26%, and herbaceous litter at 23%. In 2023, ground cover became more equal across five types: bare soil at 20%, gravel at 20%, herbaceous litter at 15%, moss at 31%, and rock at 11%.

Cheatgrass and wiregrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

Photo 25: FY22-CC-VEDU-BB-1, 8/15/22 (above)

Photo 26: FY22-CC-VEDU-BB-1, 8/28/23 (left)

Overall cheatgrass density at this site increased by 15% (6.8 plants/m^2), with 45.6 plants/m^2 in 2022 and 52.4 plants/m^2 in 2023. Cheatgrass cover remained the same at 23% and perennial grass cover decreased by 41% (65% to 24%) one year after treatment. Despite being in wiregrass area, it was not found in either year. Shrub cover increased from 3% to 6%. The majority of ground cover in 2022 was split between bare soil at 46% and herbaceous litter at 34%. In 2023, bare soil increased to 77% and herbaceous litter decreased to 20%.

Cheatgrass and wiregrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed however it should be have a site visit by specialists.

Photo 27: FY22-CC-VEDU-BB-2, 8/15/22 (above)

Photo 28: FY22-CC-VEDU-BB-2, 8/28/23 (left)

Overall cheatgrass density at this site increased by 267% (3.2 plants/m^2), with 1.2 plants/m^2 in 2022 and 4.4 plants/m^2 in 2023. Wiregrass density decreased by 100% from 5.6 plants/m^2 in 2022 and 0 plants/m^2 in 2023 (wiregrass cover was 0 in both years). Cheatgrass cover remained the same at 3% and perennial grass cover decreased by 25% (56% to 31%) one year after treatment. Shrub cover increased by 4% (7% to 11%). The majority of ground cover in 2022 was bare soil at 59%. Bare soil remained the majority cover in 2023, increasing to 79%.

Cheatgrass and wiregrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

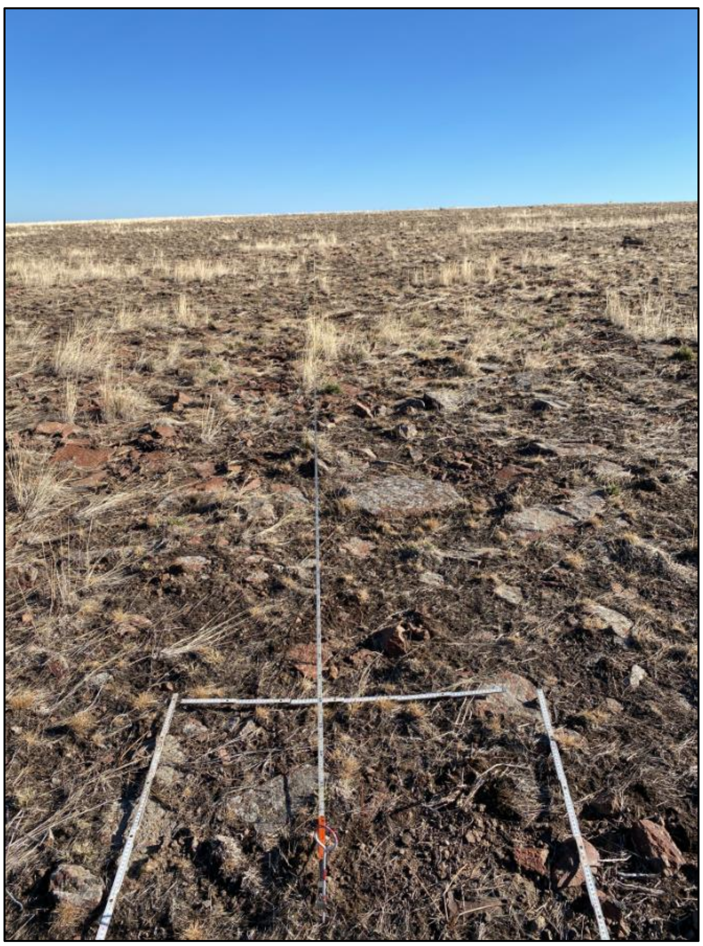

Photo 29: FY22-CC-VEDU-BB-3, 8/15/22 (above)

Photo 30: FY22-CC-VEDU-BB-3, 8/28/23 (left)

Despite cheatgrass presence in the 2022 cover survey, cheatgrass 2022 density was recorded as 0 plants/m^2. Wiregrass density decreased by 100% from 3500 plants/m^2 in 2022 to 0 plants/m^2 in 2023. Cheatgrass cover decreased by 2% (2% to 0%), wiregrass cover decreased by 80% (80% to 0%), and perennial grass cover decreased by 2% (20% to 18%) one year after treatment. There was no shrub cover in either year. The majority of ground cover in 2022 was herbaceous litter at 40%. In 2023, herbaceous litter is at 7% and bare soil makes up the majority at 56%.

Cheatgrass and wiregrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed. This site is a priority for future seeding and revegetation efforts.

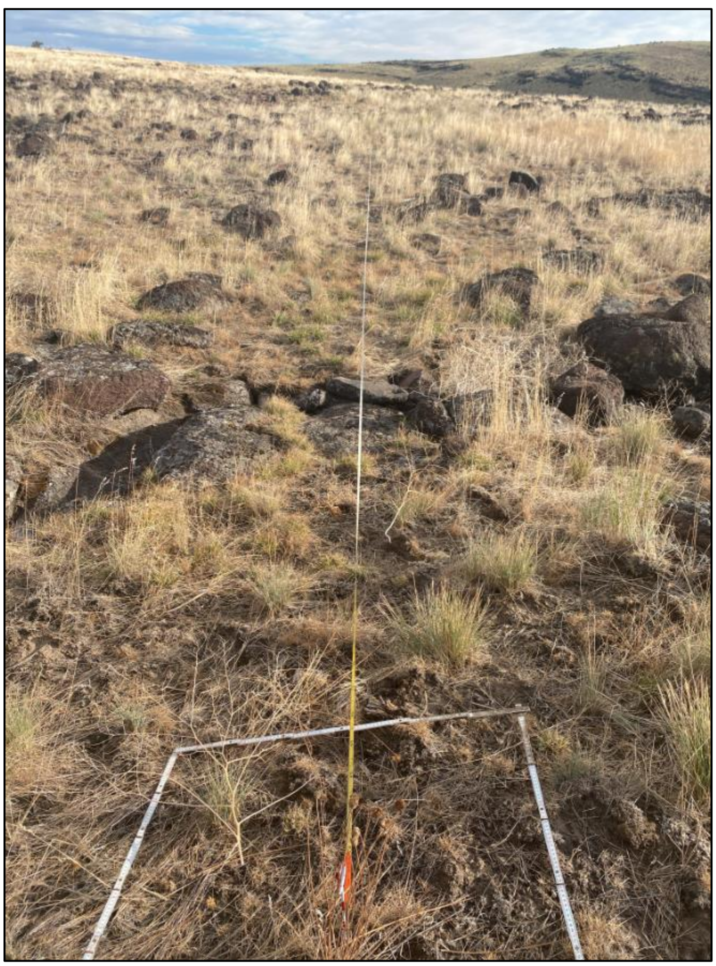

Photo 31: FY22-CC-VEDU, 8/3/22 (above)

Photo 32: FY22-CC-VEDU, 8/21/23 (left)

Overall cheatgrass density at this site decreased by 94% (245.6 plants/m^2), with 262.4 plants/m^2 in 2022 and 16.8 plants/m^2 in 2023. Wiregrass density decreased by 98% (952.4 plants/m^2), with 973.2 plants/m^2 in 2022 and 20.8 plants/m^2 in 2023. Cheatgrass cover decreased by 15% (18% to 3%), wiregrass cover decreased by 37% (44% to 7%), and perennial grass cover decreased by 8% (42% to 34%) one year after treatment. There was no shrub cover in either year. The majority of ground cover in 2022 was herbaceous litter at 41%. In 2023, herbaceous litter is at 16% and bare soil makes up the majority at 47%.

Cheatgrass and wiregrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

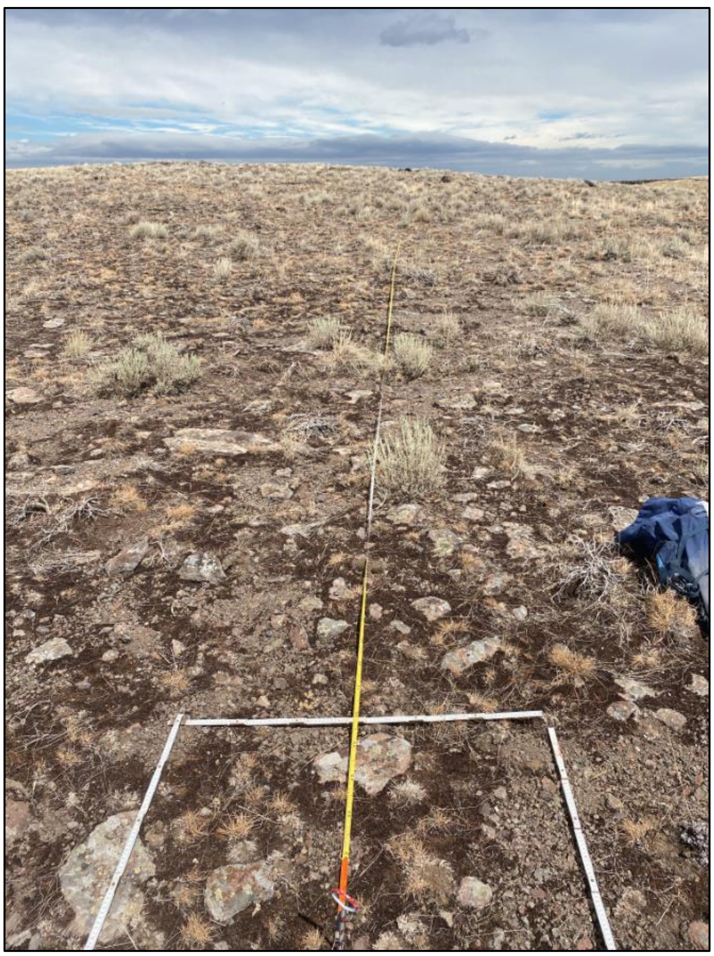

Photo 33: FY22-CC-VEDU-WDC-1, 8/3/22 (above)

Photo 34: FY22-CC-VEDU-WDC-1, 8/21/23 (left)

Overall cheatgrass density at this site decreased by 100%, with 24.4 plants/m^2 in 2022 and 0 plants/m^2 in 2023. Wiregrass density also decreased by 100%, with 20.8 plants/m^2 in 2022 and 0 plants/m^2 in 2023. Cheatgrass cover decreased by 8% (8% to 0%), wiregrass decreased by 8% (8% to 0%), and perennial grass cover decreased by 2% (18% to 16%) one year after treatment. Shrub cover increased by 5% (4% to 9%). The majority of ground cover in 2022 was split between moss at 33% and gravel at 29%. Both moss and gravel remained the dominant ground hits in 2023, each increasing slightly in percentage.

Cheatgrass and wiregrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

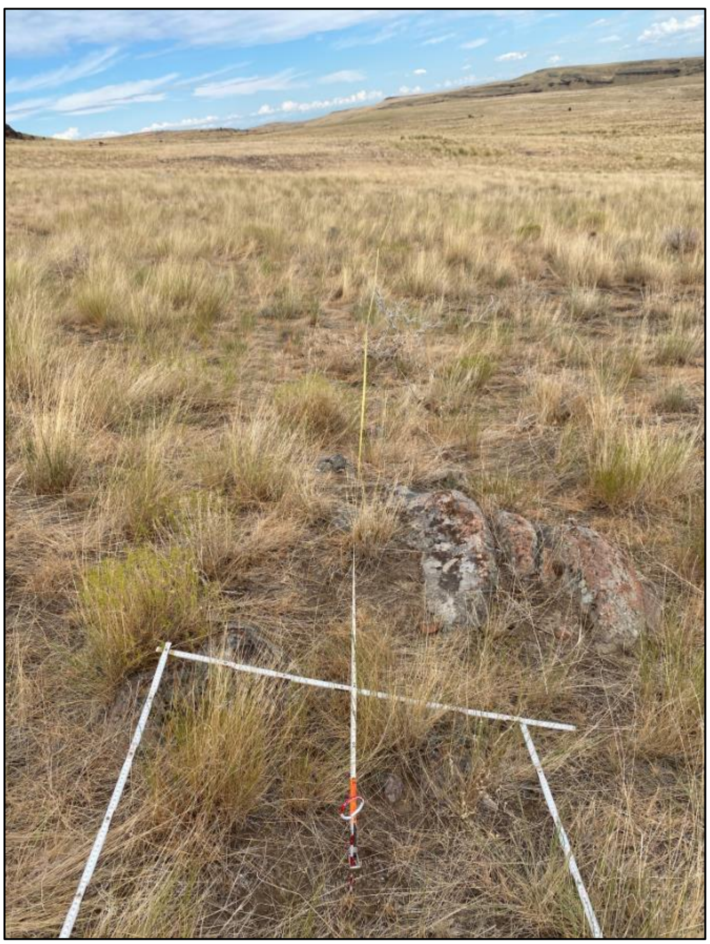

Photo 35: FY22-CC-VEDU-WDC-2, 8/3/22 (above)

Photo 36: FY22-CC-VEDU-WDC-2, 8/22/23 (left)

Overall cheatgrass density at this site decreased by 30% (21.2 plants/m^2), with 71.2 plants/m^2 in 2022 and 50 plants/m^2 in 2023, despite cover increasing. Wiregrass density decreased by 85% (595.8 plants/m^2), with 698.2 plants/m^2 in 2022 and 102.4 plants/m^2 in 2023. Cheatgrass cover increased by 7% (7% to 14%), wiregrass decreased by 34% (47% to 13%), and perennial grass cover decreased by 46% (82% to 36%) one year after treatment. Shrub cover increased by 2% (0% to 2%). The majority of ground cover in 2022 was split between bare soil at 49% herbaceous litter at 33%. In 2023, bare soil increased to 66% and herbaceous litter decreased to 26%.

The 2023 resample was close to the original point. Cheatgrass and wiregrass density post-treatment fell within acceptable range; therefore site does not need to be resprayed.

Photo 37: FY22-CC-VEDU-WDC-4, 8/8/22 (above)

Photo 38: FY22-CC-VEDU-WDC-4, 8/22/23 (left)

Cheatgrass was not present at this site in either year in both cover and density surveys. Wiregrass density increased 273% (1127.2 plants/m^2), with 650.8 plants/m^2 in 2022 and 1778 plants/m^2 in 2023. Wiregrass cover increased by 3% (20% to 23%) and perennial grass cover decreased by 32% (86% to 54%) one year after treatment. There was no shrub cover in either year. The majority of ground cover in 2022 was split between herbaceous litter at 50% and bare soil at 30%. In 2023, herbaceous litter decreased to 33% and bare soil increased to 47%.

The 2023 resample was close to the original point but the transects run in slightly different directions. Wiregrass density is too high following treatment, so site should be resprayed.